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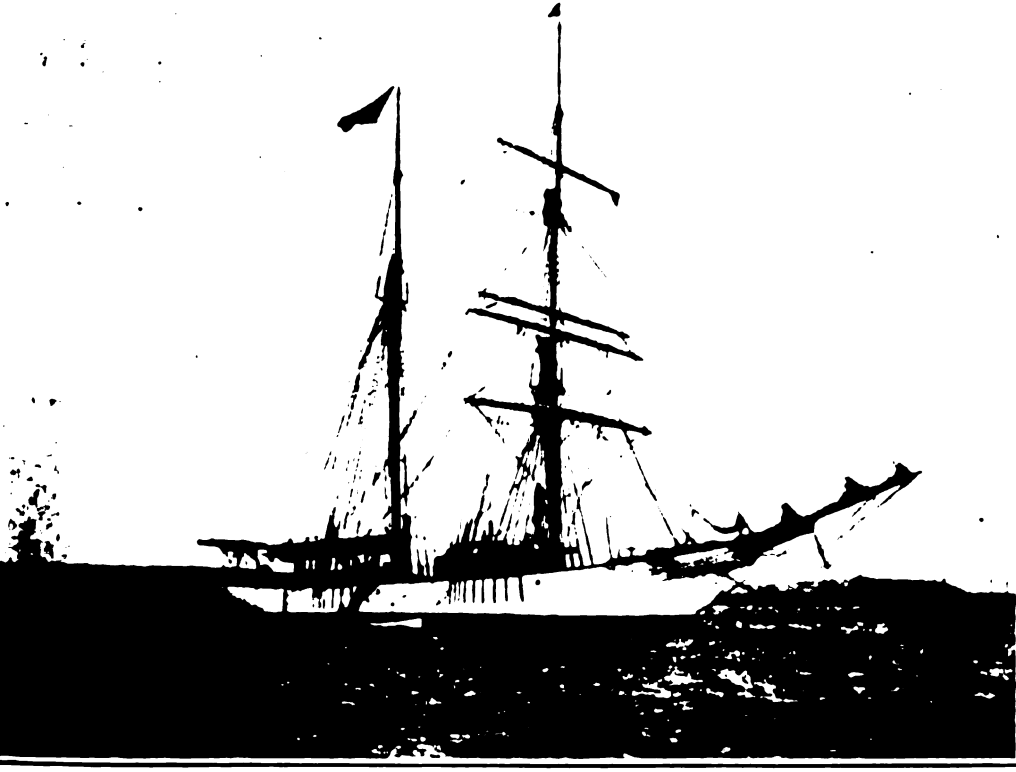

FIG. 3.—THE NONMAGNETIC YACHT CARNEGIE.

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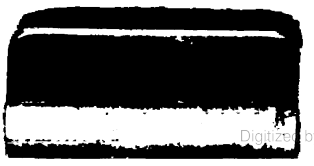

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REPORT OF THE

NATIONAL ACADEMY OF SCIENCES

FOR THE YEAR

1913

WASHINGTON
GOVERNMENT PRINTING OFFICE
1914

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CONTENTS.

	Page.
Letter of transmittal	5
Act of incorporation	7
Amendments	8
Meetings of the National Academy, 1913	9
Annual meeting—	
Business sessions—	
Members in attendance	12
Announcements of deaths since last annual meeting	13
Reports of the president and treasurer	13
Report of the home secretary	13
Report of the trustees of the Watson fund	14
Report of the committee on the J. Lawrence Smith fund	14
Report of the board of directors of the Benjamin Apthorp Gould fund	15
Report of the trustees of the Wolcott Gibbs fund	15
Report of the committee on the award of the Agassiz medal	15
Report of the committee on the semicentennial volume	16
Amendment to the charter	16
Constitutional amendment on investments	17
Change in rules	17
Business from the council	18
Dues for 1913	18
Date for elections	18
International Association of Academies	18
Fiscal advisers of the academy	18
Comstock fund	18
Administration of trust funds	18
Journal	18
Annual tables of constants	18
J. Lawrence Smith fund	18
Memorial meeting, John Shaw Billings	18
Committee personnel	18
International cooperation in volcanic observations	18
William Ellery Hale lectureship	19
Papers read by title	19
Semicentennial anniversary	19
Semicentennial fund	20
Election of officers	20
Election of members of the council	20
Election of new members	20
Election of foreign associates	21
Delegates	21
Autumn meeting—	
Attendance	21

Digitized by Google

Meetings of the National Academy, 1913—Continued.
Autumn meeting—Continued.
Business sessions— Page.
Auditing committee 21
Anniversary volume 21
Committees, 1913 22
International Association of Academies 22
The Morris Loeb bequest 22
President's report on the recommendation for Chief of Weather Bureau 23
Medal for eminence in the application of science to the public welfare 24
Report of the committee on research and trust funds 24
Annual dinner, 1914 25
Permanent building 25
Report of the special committee on the publication of a journal by the academy 25
Scientific sessions—
November 18 27
November 19 27
Papers read by title 28
Biographical notices:
Sir George Howard Darwin 28
John Shaw Billings 29
Annual report of the treasurer:
General review of financial transactions 31
Condensed statement of receipts and expenditures 32
Statement of assets and liabilities 34
Accounts with individual funds 35
Report of auditing committee 39
Appendices:
Appendix A.—Constitution of the National Academy 43
Appendix B.—Rules 49
Appendix C.—Organization of the academy, 1913–14 52
Committees of the academy 52
Trust funds 54
Members of the National Academy of Sciences, December 31, 1913 55
Honorary members 58
Foreign associates 58
Deceased members 59
Deceased foreign associates 62
Appendix D.—Semicentennial anniversary of the National Academy of Sciences 63
Addresses:
Welcome by the president of the academy. Ira Remsen 63
The Relation of Science to the Higher Education in America. Arthur T. Hadley 70
International Cooperation in Research. Arthur Schuster 75
The Earth and Sun as Magnets. George E. Hale 86
The Structure of the Universe. J. C. Kapteyn 100
Presentation of medals at the White House:
Woodrow Wilson, R. S. Woodward 109

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LETTER OF TRANSMITTAL.

NATIONAL ACADEMY OF SCIENCES,
February 28, 1914.

The Honorable THOMAS R. MARSHALL,
Vice President of the United States,
Washington, D. C.

SIR: I have the honor to transmit to you herewith the annual report of the president of the National Academy of Sciences for the year ending December 31, 1913.

Very respectfully,

ARTHUR L. DAY,
Home Secretary.

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ACT OF INCORPORATION.

AN ACT To incorporate the National Academy of Sciences.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That Louis Agassiz, Massachusetts; J. H. Alexander, Maryland; S. Alexander, New Jersey; A. D. Bache, at large; F. B. Barnard,[1] at large; J. G. Barnard, United States Army, Massachusetts; W. H. C. Bartlett, United States Military Academy, Missouri; U. A. Boyden, Massachusetts; Alexis Caswell, Rhode Island; William Chauvenet, Missouri; J. H. C. Coffin, United States Naval Academy, Maine; J. A. Dahlgren, United States Navy, Pennsylvania; J. D. Dana, Connecticut; Charles H. Davis, United States Navy, Massachusetts; George Engelmann, Saint Louis, Missouri; J. F. Frazer, Pennsylvania; Wolcott Gibbs, New York; J. M. Gilless,[2] United States Navy, District of Columbia; A. A. Gould, Massachusetts; B. A. Gould, Massachusetts; Asa Gray, Massachusetts; A. Guyot, New Jersey; James Hall, New York; Joseph Henry, at large; J. E. Hilgard, at large, Illinois; Edward Hitchcock, Massachusetts; J. S. Hubbard, United States Naval Observatory, Connecticut; A. A. Humphreys, United States Army, Pennsylvania; J. L. Le Conte, United States Army, Pennsylvania; J. Leidy, Pennsylvania; J. P. Lesley, Pennsylvania; M. F. Longstreth, Pennsylvania; D. H. Mahan, United States Military Academy, Virginia; J. S. Newberry, Ohio; H. A. Newton, Connecticut; Benjamin Peirce, Massachusetts; John Rodgers, United States Navy, Indiana; Fairman Rogers, Pennsylvania; R. E. Rogers, Pennsylvania; W. B. Rogers, Massachusetts; L. M. Rutherford, New York; Joseph Saxton, at large; Benjamin Silliman, Connecticut; Benjamin Silliman, junior, Connecticut; Theodore Strong, New Jersey; John Torrey, New York; J. G. Totten, United States Army, Connecticut; Joseph Winlock, United States Nautical Almanac, Kentucky; Jeffries Wyman, Massachusetts; J. D. Whitney, California; their associates and successors duly chosen, are hereby incorporated, constituted, and declared to be a body corporate, by the name of the National Academy of Sciences.

SEC. 2. *And be it further enacted,* That the National Academy of Sciences shall consist of not more than fifty ordinary members, and the said corporation hereby constituted shall have power to make its own organization, including its constitution, by-laws, and rules and regulations; to fill all vacancies created by death, resignation, or

[1] The official list of members gives the name of F. A. P. Barnard.

[2] The official list of members gives the name of J. M. Gillis.

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otherwise; to provide for the election of foreign and domestic members, the division into classes, and all other matters needful or usual in such institution, and to report the same to Congress.

SEC. 3. *And be it further enacted,* That the National Academy of Sciences shall hold an annual meeting at such place in the United States as may be designated, and the Academy shall, whenever called upon by any Department of the Government, investigate, examine, experiment, and report upon any subject of science or art, the actual expense of such investigations, examinations, experiments, and reports, to be paid from appropriations which may be made for the purpose, but the Academy shall receive no compensation whatever for any services to the Government of the United States.

Approved, March 3, 1863.

AMENDMENTS.

AN ACT To amend the act to incorporate the National Academy of Sciences.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the act to incorporate the National Academy of Sciences, approved March third, eighteen hundred and sixty-three, be, and the same is hereby, so amended as to remove the limitation of the number of ordinary members of said academy as provided in said act.

Approved, July 14, 1870.

AN ACT To authorize the National Academy of Sciences to receive and hold trust funds for the promotion of science, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the National Academy of Sciences, incorporated by the act of Congress approved March third, eighteen hundred and sixty-three, and its several supplements, be, and the same is hereby, authorized and empowered to receive bequests and donations and hold the same in trust, to be applied by the said academy in aid of scientific investigations and according to the will of the donors.

Approved, June 20, 1884.

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ANNUAL REPORT

OF THE

NATIONAL ACADEMY OF SCIENCES.

MEETINGS OF THE NATIONAL ACADEMY.

During the year 1913 the academy held two stated meetings, the annual meeting in April at Washington and the autumn meeting in November at the Johns Hopkins University in Baltimore, Md.

Inasmuch as the date of the annual meeting fell within a few days of the fiftieth anniversary of the first meeting of the National Academy of Sciences on April 22, 1863, a formal session was held on April 15, as prescribed by the constitution, from which a recess was taken to April 22, 23, and 24, when appropriate ceremonies commemorative of the anniversary of the founding of the academy were held.

The program of the anniversary meeting included a reception at the White House and the presentation by the President of the United States of the following academy medals and prizes:

Watson Medal for Researches in Astronomy: Jacobus Cornelius Kapteyn, director of the Astronomical Laboratory, University of Groningen, Groningen, Netherlands.

Draper Medal for Discoveries in Astronomical Physics: Henri Deslandres, director of the Astrophysical Observatory at Meudon, France.

Alexander Agassiz Gold Medal for original contributions to the Science of Oceanography: Johan Hjort, Fiskeridirektøren, Bergen, Norway.

Watson Prize, $100: Jacobus Cornelius Kapteyn, director of the Astronomical Laboratory, University of Groningen, Groningen, Netherlands.

Comstock Prize for research in electricity, magnetism, and radiant energy, $1,500: Robert Andrews Millikan, University of Chicago, Chicago, Ill.

The program also included formal addresses by invited guests of the academy as follows:

The relation of science to the higher education in America, President Arthur T. Hadley of Yale.

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International cooperation in research, Dr. Arthur Schuster, secretary of the Royal Society of London.

The earth and sun as magnets, Dr. George E. Hale, director of the Mount Wilson Solar Observatory.

The structure of the universe, Dr. J. C. Kapteyn, director of the Astronomical Laboratory, University of Groningen, Groningen, Netherlands.

The festival character of the gathering and the large number of members and guests assembled to celebrate the anniversary gave opportunity for several social meetings which added greatly to the pleasure of the occasion. In addition to the reception at the White House by the President of the United States and Mrs. Wilson, in connection with the presentation of the medals, receptions were given to the academy by the Smithsonian Institution in the National Gallery of Art, in the National Museum, and by the Carnegie Institution of Washington at its administration building. Through the courtesy of the Secretary of the Navy, the U. S. S. *Mayflower* was placed at the disposal of the members of the academy and their guests for an excursion to the historic home of Washington at Mount Vernon. The celebration was closed by a formal dinner at the New Willard Hotel, with the following list of toasts and distinguished speakers:

Toast: To the President of the United States.

After-dinner speeches:

The relations of science to government, Honorable Thomas R. Marshall, Vice President of the United States.

Foreign academies and societies, Honorable James Bryce, British Ambassador.

Reminiscences of the academy, Dr. Silas Weir Mitchell.

American Philosophical Society, Dr. W. W. Keen, president of the American Philosophical Society.

Legislation and the National Academy of Sciences, Senator Theodore E. Burton.

In connection with this celebration of the fiftieth anniversary of the founding of the academy, a historical volume of some 400 pages was published by the academy, containing an accurate record of its activities throughout the 50 years of its history. The volume also contains an account of the foundation of the academy in 1863, at a time when the country was in the throes of civil war, biographical sketches of the 50 original incorporators, and a final chapter, which occupies nearly half of the volume, containing the record of the commissions which the academy has undertaken as an advisory body in the service of the United States Government. The records show that of the whole number of committees appointed at the bidding of the various departments of the Government, more than one-third

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were called into being during the first five years of the existence of the academy, and of the subjects thus submitted for consideration, many were concerned with the solution of technical questions which had arisen in the conduct of the war.

The subjects brought to the attention of the academy by the Government have covered a wide range, but matters in which physics, astronomy and chemistry were concerned have predominated. It should be remarked, however, that some of the most important questions which the academy has been asked to consider have not related to any particular branch of science, but rather to matters of public policy.

In all, the academy has considered and reported upon 54 questions at the request of the Government of the United States.

Of the attitude of the academy toward these questions which have been intrusted to it by the Congress and the various departments of the Government, there is no better expression than the following extract from the report of the first president of the academy, Prof. Alexander Dallas Bache, published in his report for the years 1863–1864 (p. 50):

> It will be seen by the spirit and words of our laws, enacted by the authority of the charter, that the members of the National Academy put their time and talents at the disposal of the country in no small or stinted measure—freely, fully, by the binding authority of an oath—asking no compensation therefor but the consciousness of contributing to judicious action by the Government on matters of science. The more the wealth of such men can be drawn out from the treasury of their knowledge, the richer will the Nation be. * * *

In addition to the historical volume containing the record of the activity of the academy during the first 50 years of its existence, an anniversary volume was published and distributed to the members at the autumn meeting in Baltimore, containing the complete record of the semicentennial meeting and of the addresses delivered on that occasion.

In closing this chapter of the history of the academy, and entering upon another, it is but natural to consider in what way the usefulness of the academy may be increased, whether to the Government as an adviser constituted by law to aid in the solution of problems requiring special knowledge, or to American science, toward which, as the constituted adviser of the Government, it has certain duties of leadership. This is perhaps not the place for the detailed consideration of so large a question, but in the meetings of this fiftieth anniversary year, this question has been much in the minds of the membership and has been freely discussed. Out of this discussion two definite conclusions have emerged which are esteemed to be of great importance to the future usefulness of the academy, to which the attention of the Congress may properly be called. The first is the need for a building

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in which its library and records may be preserved, and its meetings and scientific functions appropriately provided for; the second, the need for a regular publication in which the scientific activities of its members, of its distinguished foreign associates, and of those who may be invited to speak before it, may properly be recorded.

It is hard to see how a national academy can take its appropriate place as the representative American scientific body in the counsels of international science,[1] or how it can assume the position of leadership in our own country which is its plain duty in virtue of its representative membership, so long as it possesses neither a "local habitation" nor an organ through which to give appropriate expression to its views. Some opportunity to assert and some power to assist in maintaining the highest ideals in American scientific research, some means through which the successful investigator may influence the progress and extension of scientific effort in the field in which he has achieved success, a home to which the public may be invited to listen to lectures and demonstrations upon subjects of national scientific interest, and the power to confer some recognition of scientific accomplishment—all these would appear to be indispensable to the greatest usefulness of an officially constituted national scientific body.

The academy accordingly respectfully invites the attention of the Congress of the United States to the fact that it possesses no building equipped for public demonstrations of scientific progress, no laboratory for the prosecution of scientific studies, and no organ through which to voice its views or to record the individual achievements of its members, all of which are deemed to be essential to its proper participation in any movement for the advancement of American science.

ANNUAL MEETING.

BUSINESS SESSIONS.

The business sessions were held in the new building of the United States National Museum, Washington, D. C., April 15, 22, 23, 24, 1913.

Seventy-four members were present, as follows: Abbe, Barnard, Becker, Boas, Boltwood, Bolza, Campbell, Cattell, Chandler (C. F.), Chittenden, Clark (W. B.), Clarke (F. W.), Clarke (J. M.), Comstock, Conklin, Councilman, Cross, Dall, Davenport, Davis, Day, Flexner, Gill, Hague, Hale, Harper, Hastings, Hillebrand, Holmes, Howell, Iddings, Kemp, Lindgren, Loeb, Mall, Meltzer, Mendenhall, Merriam, Minot, Mitchell, Morgan, Morley, Morse (E. S.), Morse (H. N.), Moulton, Nef, Nichols, Noyes (A. A.), Noyes (W. A.), Osborn (H. F.), Osborne (T. B.), Peirce (B. O.), Prudden, Pupin,

[1] The academy has in fact already been under the somewhat humiliating necessity of declining to entertain the International Association of Academies, which is the court of highest appeal for great questions of international science, because of lack of facilities.

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Reid, Remsen, Schuchert, Scott, Smith (Theobald), Stieglitz, Thomson, Trelease, Van Hise, Van Vleck, Walcott, Webster, Welch, Wells, Wheeler, White, Wilson, Wood (R. W.), Woodward.

The president announced the death, since the last annual meeting, of the following members: Lewis Boss, October 5, 1912; John Shaw Billings, March 11, 1913; and one foreign associate, Sir George Howard Darwin, December 7, 1912.

REPORTS OF THE PRESIDENT AND TREASURER.

The reports of the president [1] and of the treasurer [2] for 1912, as transmitted to the Senate of the United States by the president of the academy, were presented in their printed form and approved.

REPORT OF THE HOME SECRETARY.

THE PRESIDENT OF THE NATIONAL ACADEMY OF SCIENCES.

SIR: I have the honor to present herewith the annual report of the home secretary of the National Academy of Sciences for the year ending April 24, 1913.

The annual report of the president of the academy for the year 1912 was transmitted to the United States Senate January 27, 1913, through the courtesy of Senator George P. Wetmore. The edition of 2,000 copies, authorized by Congress, was printed; 500 copies for the use of the Senate, 1,000 copies for the use of the House of Representatives, and 500 copies for distribution by the National Academy of Sciences.

The report was received from the Government Printing Office March 13, 1913. Copies have been distributed to the members, foreign associates, institutions, and reference libraries on our exchange list. During the year the rest of the limited edition will be distributed, on application, to learned societies and members of the academy. A small number has been reserved for the use of the members.

At the annual meeting in April, 1912, the following were elected to membership in the academy: John Jacob Abel, Johns Hopkins University, Baltimore, Md.; Charles Benedict Davenport, Station for Experimental Evolution, Cold Spring Harbor, N. Y.; Samuel James Meltzer, Rockefeller Institute for Medical Research, New York City; Harry Fielding Reid, Johns Hopkins University, Baltimore, Md.; Roland Thaxter, Harvard University, Cambridge, Mass.; William Morton Wheeler, Harvard University, Cambridge, Mass.; David White, United States Geological Survey, Washington, D. C.; and Robert Williams Wood, Johns Hopkins University, Baltimore, Md.

Sir John Murray was elected foreign associate at the same meeting.

The memoir by Mr. Trelease, entitled "Agave in the West Indies," and illustrated by 120 plates, forms volume XI of the Memoirs of the National Academy of Sciences. The edition was received from the Government Printing Office April 19, 1913.

There has also been transmitted to the Government Printing Office the manuscript and plates of a memoir entitled "Monograph of the Bombycine Moths of North America," by A. S. Packard, which is to appear as volume XII First Memoir, of the Memoirs of the National Academy of Sciences.

The following biographical memoirs have been published during the year: "Charles Otis Whitman," by Edward S. Morse; "Alexander Agassiz," by George W. Goodale; "Samuel Franklin Emmons," by Arnold Hague; and "Joseph Leidy," by Henry Fairfield Osborn.

The committee having in charge the selection of an artist for the Alexander Agassiz gold medal, founded by Sir John Murray, selected Theodore Spicer-Simson, of Paris.

[1] Report of the National Academy of Sciences for the year 1912, pp. 9-24. [2] Idem, pp. 25-31.

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Later the design for the medal was referred to the council for approval and accepted. The President was empowered to appoint a committee, Messrs. Dall, Gill, and Hague, to name the recipient. This committee awarded the medal to Johan Hjort, of the Norwegian Fish Commission, Bergen, Norway.

The semicentennial volume has been completed, and copies will be presented at the anniversary meeting. The book is in royal octavo form and is entitled "The National Academy of Sciences, 1863–1913." It contains 400 pages and 12 illustrations.

The text is divided into four chapters, as follows: Chapter 1, The Founding of the Academy; Chapter 2, The Annals of the Academy; Chapter 3, Biographical Sketches of the Incorporators; Chapter 4, The Academy as the Scientific Adviser of the Government. In addition, the book contains several appendices, comprising lists of officers, members, foreign associates, and medalists, and also a list of the publications and reports of committees, together with other matter useful for reference. The illustrations consist of portraits of the seven presidents of the academy, and of Senator Henry Wilson, who introduced the bill of incorporation in Congress, and of facsimiles of the Draper, Smith, and Watson medals, and the diploma of the academy.

Two members have died since the last annual meeting: Lewis Boss, on October 5, 1912, and John Shaw Billings, on March 11, 1913.

Of our foreign associates we have to record the death of Sir George Howard Darwin, on December 7, 1912.

There are 122 active members on the membership list, 1 honorary member, and 38 foreign associates.

ARNOLD HAGUE,
Home Secretary.

APRIL '22, 1913.

REPORT OF THE TRUSTEES OF THE WATSON FUND.

The trustees of the Watson fund respectfully report that good progress has been made in the discussion of the Watson asteroids. Prof. Leuschner states that, in addition to the twelve asteroids for which tables are published in Volume X of the "Memoirs of the National Academy of Sciences," tables for three others (79) Eurynome, (121) Hermione, and (150) Nuwa are now nearly ready for publication. One planet, (132) Æthra, may be regarded as lost. The revision of von Zeipel's theory is nearly completed. It is expected that by July, 1914, the whole work will be finished, including the tables for the ten planets as yet unpublished. We therefore recommend that besides the balance of last year's appropriation remaining unexpended on June 30, 1913, $70 a month, or $840 for the year ending June 30, 1914, be appropriated, or as much thereof as may be needed for the completion of the Watson work. As the balance on hand of the Watson fund on January 1, 1913, was $1,169, and the annual income is about $1,000, it is hoped that this will permit some other work to be undertaken.

EDWARD C. PICKERING.
W. L. ELKIN.

REPORT OF THE COMMITTEE ON THE J. LAWRENCE SMITH FUND.

TO THE NATIONAL ACADEMY OF SCIENCES:

The committee on the J. Lawrence Smith fund reports in regard to researches now in progress, which have been aided by this fund, as follows:

Grant No. 1: Edmund Otis Hovey, curator in the department of geology and paleontology in the American Museum of Natural History, New York, received in 1910 a grant of $400 to aid in the study of certain meteorites. The metallographic and chemical examinations involved are in satisfactory progress.

Grant No. 2: C. C. Trowbridge, professor of physics in Columbia University, received in 1910 a grant of $400 in aid of his study of the luminous trains of some

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meteorites. This work was further aided by a grant of $250 in 1912, and the academy then authorized the committee to make three further annual grants of the last-named amount. They are about to make such a grant for this year.

Grant No. 3: George P. Merrill, curator in the department of geology in the United States National Museum, received in 1910 a grant of $200, and in 1911 a further grant of a like amount to assist in studying the reported presence of certain elements suspected to occur in small quantities in some meteorites. This work is successfully completed, a preliminary report of its results has been submitted for the information of the committee, and a final report will be ready before the autumn meeting of the academy.

The unexpended income from the fund now available for grants is $741.58.

For the committee on the J. Lawrence Smith fund.

EDWARD W. MORLEY, *Chairman.*

REPORT OF THE BOARD OF DIRECTORS OF THE BENJAMIN APTHORP GOULD FUND.

The income balance of the Gould fund is now about four thousand five hundred dollars ($4,500). Of this balance about three thousand six hundred dollars ($3,600) are invested in readily negotiable securities.

It was suggested in the deed of gift that at least a portion of the income of this fund should be devoted to the support of the Astronomical Journal. In accordance with this suggestion, and with the action of the board of directors of the Gould fund of the last two years, this policy has been continued. On February 20, 1913, a warrant was given for an appropriation of three thousand dollars ($3,000) for the use of the Astronomical Journal, with the understanding that all previous appropriations for this purpose, which had not been expended, were to revert back to the Gould fund. This appropriation will undoubtedly meet the needs of the Astronomical Journal until the spring of 1914.

G. W. HILL,
SETH C. CHANDLER,
F. R. MOULTON,
Directors of the Gould Fund.

REPORT OF THE TRUSTEES OF THE WOLCOTT GIBBS FUND.

The trustees of the Wolcott Gibbs fund have the honor to report that no appropriations have been made from the income of the fund this year.

C. L. JACKSON, *Chairman.*

APRIL 22, 1913.

REPORT OF THE COMMITTEE ON THE AWARD OF THE AGASSIZ MEDAL.

To the PRESIDENT AND MEMBERS OF THE ACADEMY.

GENTLEMEN: Upon the acceptance by the academy of the liberal gift made by Sir John Murray, of a permanent fund, the interest on which should be devoted to the presentation from time to time of a gold medal, to be known as the Alexander Agassiz medal, for original contributions to the science of oceanography, the president appointed a committee to select an artist to design a suitable die and furnish the first medal.

After this committee had chosen Theodore Spicer-Simson as artist, and the first medal had been ordered cast in Paris, it was formally accepted in the name of the academy. In pursuance of the following resolution:

"*Resolved*, That the president be empowered to select a committee of three to name the recipient of the Agassiz medal,"

the following committee was appointed: William H. Dall, Theodore N. Gill, and Arnold Hague. The committee, after careful consideration of the names proposed,

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voted to recommend as the recipient of the first medal Dr. Johan Hjort, of the Norwegian Fish Commission, for his valuable contributions to knowledge relating to deep-sea life. Dr. Hjort was joint author with Sir John Murray in the preparation of the recent Reports on the Scientific Results of the "Michael Sars" North Atlantic Deep Sea Expedition.

At the autumn meeting of the academy the following resolution was adopted:

"*Resolved*, That the council be authorized to approve the recommendations of all committees regarding the award of medals for the year 1913."

The council approved the action of this committee.

ARNOLD HAGUE, *Chairman.*

WASHINGTON, *April 15, 1913.*

REPORT OF THE COMMITTEE ON THE SEMICENTENNIAL VOLUME OF THE NATIONAL ACADEMY OF SCIENCES.

To the PRESIDENT AND MEMBERS OF THE ACADEMY.

GENTLEMEN: As early as April, 1908, several members of the academy expressed a wish to have collected the material for a volume that would show the influences at work which led up to the incorporation of the National Academy of Sciences, and a history of the early days of the organization together with a concise statement of the scientific work accomplished by the academy. It was decided in 1909 to prepare such a volume in connection with the semicentennial celebration, the scope of the publication to follow in a general way on the lines suggested the previous year. A committee, consisting of Messrs. Chittenden, Councilman, Hague, Trelease, and Walcott, was appointed to carry out the wishes of the academy.

In the spring of 1910 the committee secured the services, as editor, of Dr. F. W. True, Assistant Secretary of the Smithsonian Institution. The work required much time and labor. The preface is dated January 10, 1913. Advance copies of the volume will be laid before the academy at this meeting, and soon after the book will be forwarded to all members and foreign associates.

It may be well to state here that the volume, containing 400 pages, was printed by the Lord Baltimore Press, an edition of 1,000 copies having been authorized. The text is divided into four chapters, accompanied by 12 full-page illustrations and several appendices. The members of the committee have given much thought to the general appearance of the volume. They believe the book will prove to be of permanent scientific value, and a useful work of reference to all members of the academy.

ARNOLD HAGUE, *Chairman.*

WASHINGTON, *April 22, 1913.*

AMENDMENT TO THE CHARTER.

The treasurer reported that in accordance with the terms of a resolution adopted at the last autumn meeting, authorizing him to secure legal advice regarding the pooling of the funds of the academy for purposes of investment, he had consulted the firm of MacVeagh, McKenney & Flannery, submitting the charter of the academy, the terms of the different deeds of gift, and a statement of what was desired by the academy, and that he had received an opinion showing the legal necessity for the following amendment to the charter of the academy:

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PROPOSED AMENDMENT TO THE CHARTER OF THE NATIONAL ACADEMY OF SCIENCES.

AN ACT TO amend the act authorizing the National Academy of Sciences to receive and hold trust funds for the promotion of science and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the act to authorize the National Academy of Sciences to receive and hold trust funds for the promotion of science and for other purposes, approved June twentieth, eighteen hundred and eighty-four, be, and the same is hereby, amended to read as follows: That the National Academy of Sciences, incorporated by the act of Congress approved March third, eighteen hundred and sixty-three, be, and the same is hereby, authorized and empowered to receive by devise, bequest, donation, or otherwise, either real or personal property, and to hold the same absolutely or in trust and to invest, reinvest, and manage the same in accordance with the provisions of its constitution, and apply said property and the income arising therefrom to the objects of its creation and according to the instructions of the donors.

On the recommendation of the council the academy adopted the following resolution:

Whereas legal opinion has shown the present charter of the academy to be unduly restrictive, not only in regard to the management of the funds intrusted to the academy, but also in the terms under which such bequests may be accepted and applied:

Resolved, That the academy take such steps as may be necessary to secure the adoption of the proposed amendment to the charter of the academy.

CONSTITUTIONAL AMENDMENT ON INVESTMENTS.

The following amendment to section 1 of Article VI of the constitution, which was adopted in committee of the whole at the autumn meeting in New York City, was adopted:

All investments shall be made by the treasurer in the corporate name of the academy with the approval of a finance committee of three members, to be appointed annually by the president, of which the treasurer shall be one. Investments shall be made in bonds of the United States, in State bonds, or bonds or notes secured by first mortgages on real estate, in investments legal for savings banks under the laws of Massachusetts or New York, or in other bonds recommended to the treasurer by the fiscal advisers of the academy.

The council shall, at its annual meeting in each year, designate one bank or trust company in Washington, D. C., and one in New York City to act, when requested by the treasurer, as the fiscal advisers of the academy.

The treasurer shall have the authority, with the approval of the finance committee, to change any investment held by him in the corporate name of the academy.

CHANGE IN RULES.

The following change in the rules was adopted:

That the word *shall* in line 2 of Rule II be changed to read *may*, as follows:

"II. On the first day of each stated session, immediately after calling the roll of members, a recording secretary *may* be elected, by a plurality of members present, to assist the home secretary in keeping the records of the session."

33245—S. Doc. 437, 63-2——2

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BUSINESS FROM THE COUNCIL.

The following recommendations of the council were adopted by vote of the academy:

That the annual dues for 1913 be five dollars.

That the election of president, vice president, home secretary, two members of the council, new members, and foreign associates be held on Thursday morning, April 24.

That the treasurer be authorized to pay the annual subscription of 200 francs to the International Association of Academies.

That the American Security & Trust Co., of Washington, D. C., and Spencer Trask & Co., bankers, of New York City, be designated the fiscal advisers of the academy for 1913-14.

That in accordance with article 3 of the deed of gift of the Cyrus B. Comstock fund, the treasurer be hereby directed to transfer to the capital of that fund the balance of the accumulated income remaining on April 22, 1913, after providing for the payment of the Comstock prize of $1,500 and other incidental expenses.

The appointment of a special committee to consider and report upon plans for systematizing, properly recording, and otherwise improving the administration of the trust funds of the academy available for research, medals, and prizes.

That a special committee be appointed to report at the next meeting of the academy on the advisability of publishing some form of journal, and that the said committee be requested to consider especially a form of journal which shall consist of brief communications from members of the academy making original announcement of the results of their researches, and describing them in summarized form.

That a grant of $200, or such portion of it as may be approved by the president and foreign secretary, be made from the general funds of the academy as a subvention in support of the annual tables of constants, published under the patronage of the International Association of Academies.

That a grant of $400 be made from the J. Lawrence Smith fund to Dr. George P. Merrill, of the United States National Museum, to continue his investigations of certain elements occurring in meteorites.

That Dr. S. Weir Mitchell represent the academy at the memorial meeting, April 25, 1913, at the New York Public Library, in honor of John Shaw Billings, LL. D., D. C. L., deceased.

ANNOUNCEMENTS OF COMMITTEE PERSONNEL.

E. C. Pickering was appointed on the committee on solar research in place of G. C. Comstock, resigned.

F. R. Moulton chairman of the Gould fund in place of Lewis Boss, deceased.

E. C. Pickering chairman of the Watson fund in place of Lewis Boss, deceased.

INTERNATIONAL COOPERATION IN VOLCANIC OBSERVATIONS.

That the delegate from the academy to the meeting of the International Association of Academies be instructed that the National Academy of Sciences approves of international cooperation in volcanic observations, without financial responsibility.

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WILLIAM ELLERY HALE LECTURESHIP.

The following is the text of the formal offer made to the academy by the children of the late William Ellery Hale:

In memory of William Ellery Hale, and in recognition of his interest in education and the advancement of science, we offer to the National Academy of Sciences the sum of $5,000 for public lectures under the auspices of the academy. This sum, which is available under the will of William Ellery Hale, is to be paid in annual installments of $1,000 each on the first day of January of the years 1914 to 1918, inclusive. We hope hereafter to be able to make provision for a permanent annual income to the academy for the above purpose, but limit this offer to the period of five years.

GEORGE E. HALE.
MARTHA HALE HARTS.
WILLIAM B. HALE.

Accepted by the academy with a rising vote of thanks.

PAPERS READ BY TITLE.

H. F. Osborn, "Cope Biography and Bibliography."
William Trelease, "The Oaks of Tropical America."
George C. Comstock, "Biography of John H. C. Coffin."
J. U. Nef, "A condensed summary of the main results obtained in nine years' work on the simple sugars."
J. U. Nef, "On the β and γ monomolecular lacteries of d. maunonic and d. gluconic acids and their sugars, the polysaccharides and the glucosides."
J. U. Nef, "On the synthesis of the polysaccharides from the simple sugars."
Benjamin Boss (introduced by Arnold Hague), "Biography of Lewis Boss."
Joseph E. Pogue (introduced by C. D. Walcott), "The Turquoise."

REPORT OF THE LOCAL COMMITTEE ON THE SEMICENTENNIAL ANNIVERSARY.

The following official program for the Semicentennial Anniversary of the National Academy of Sciences was carried out in full, with the single exception of the address by Dr. Theodor Boveri, "On the Material Basis of Heredity." Dr. Boveri was prevented by illness from attending the celebration.

PROGRAM.

TUESDAY, APRIL 22.

9.30 a. m. Business meeting of the academy in the National Museum. Members of the academy only.

11 a. m. Opening session, National Museum. Members of the academy and guests. Welcome by the president of the academy. Addresses: "The Relation of Science to the Higher Education in America," President Arthur T. Hadley, of Yale;[1] "International Cooperation in Research," Dr. Arthur Schuster,[2] secretary of the Royal Society of London.

1.30 p. m. Luncheon in the grill room of the Hotel Raleigh. Members of the academy and guests.

3 p. m. Afternoon session, National Museum. Members of the academy and guests. Address: "The Earth and Sun as Magnets," Dr. George E. Hale, Director of the Mount Wilson Solar Observatory.[3]

9 p. m. Reception by the Regents and Secretary of the Smithsonian Institution to the members of the academy and invited guests at the National Museum.

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[1] Printed in full on page 70.
[2] Printed in full on page 75.
[3] Printed in full on page 86.

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WEDNESDAY, APRIL 23.

10.30 a. m. Morning session, National Museum. Members of the academy and guests. Addresses: "On the Material Basis of Heredity," Dr. Theodor Boveri, University of Würzburg; "The Structure of the Universe," Dr. J. C. Kapteyn, director of the Astronomical Laboratory, University of Groningen.[1]

1 p. m. Luncheon in the grill room of the Hotel Raleigh. Members of the academy and guests.

3.30 p. m. Reception at the White House and presentation of medals[2] by the President of the United States. Members of the academy and guests.

9 p. m. Reception by the trustees of the Carnegie Institution of Washington to members of the academy and invited guests.

THURSDAY, APRIL 24.

9 a. m. Meeting of the council at the National Museum.

9.30 a. m. Business meeting of the academy at the National Museum. Members of the academy only.

10 a. m. During the business meeting of the academy opportunity will be given to guests to visit the scientific bureaus and laboratories of Washington.

12.30 p. m. Luncheon in the oak room of the Hotel Raleigh. Members of the academy only.

2 p. m. Excursion to the home of Washington at Mount Vernon by the U. S. S. *Mayflower*. By courtesy of the Secretary of the Navy.

8 p. m. Dinner at the New Willard Hotel.

The treasurer, Mr. Cross, has submitted the following statement of the funds collected for the celebration:

Received	$3,907.50
Expenditures	3,653.75
Unexpended balance	253.75

The special appropriation of one thousand dollars from the general fund of the academy for use, if needed, was not drawn upon.

ARTHUR L. DAY, *Chairman*.

ELECTION OF OFFICERS.

William H. Welch was elected president for the term of six years, ending with the annual meeting in 1919.

Charles D. Walcott was elected vice president for the term of six years, ending with the annual meeting in 1919.

Arthur L. Day was elected home secretary for the term of six years, ending with the annual meeting in 1919.

ELECTION OF MEMBERS OF THE COUNCIL.

Russell H. Chittenden and Edmund B. Wilson were elected members of the council for the term of three years, ending with the annual meeting in 1916.

ELECTION OF NEW MEMBERS.

The following were elected to membership in the academy: Henry Andrews Bumstead, Leonard Eugene Dickson, Ross Granville Harri-

[1] Printed in full on page 100.
[2] Presentation addresses printed in full on page 109.

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son, Armin Otto Leuschner, Gilbert Newton Lewis, Lafayette Benedict Mendel, George Howard Parker, Louis Valentine Pirsson, Edward Bennett Rosa, and Erwin Frink Smith.

ELECTION OF FOREIGN ASSOCIATES.

The following were elected foreign associates: Theodor Boveri, William Crookes, Gaston Darboux, Henri Deslandres, Albert Heim, Albrecht Kossel, Karl Friedrich Küstner, Arthur Schuster, Johannes D. Van der Waals, August Weismann, Max F. J. C. Wolf.

DELEGATES.

Dr. George E. Hale to represent the academy on the council of the International Association of Academies at the meeting to be held in St. Petersburg during the week of May 11, 1913.

To the Douzième Congrès Géologique International, Toronto, 1913: George F. Becker, Whitman Cross, Arnold Hague, Waldemar Lindgren, and David White.

AUTUMN MEETING.

The business session of the autumn meeting of the academy was called to order by President Welch on November 18, 1913, at 10.10 a. m., in the lecture room of the physical laboratory of Johns Hopkins University, Baltimore, Md.

The home secretary called the roll of the academy, and the following members responded: Messrs. Abel, Ames, Becker, Cattell, Chittenden, Clark, Clarke (F. W.), Conklin, Crew, Cross, Dall, Davenport, Day, Flexner, Hague, Harper, Harrison, Hillebrand, Howell, Iddings, Kemp, Loeb, Mall, Meltzer, Mendel, Minot, Mitchell, Morse (H. N.), Nichols (E. L.), Noyes (A. A.), Osborne (T. B.), Pirsson, Reid, Remsen, Rosa, Walcott, Webster, and Welch.

The minutes of the preceding meeting (April 24, 1913) were read and approved.

AUDITING COMMITTEE.

The president announced the following auditing committee for the year 1913: William H. Dall (chairman), F. W. Clarke, Arthur L. Day.

ANNIVERSARY VOLUME.

The home secretary announced that the anniversary volume containing the record of the addresses, the presentation of medals at the White House, the after-dinner speeches at the formal dinner of the members and their guests, and the reproduction of the register, which was authorized by the council at its meeting on May 21, 1914, had been published and copies were distributed to the members of the academy present.

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COMMITTEES, 1913.

The President announced the appointment of the following committees:

Committee on Chief of Weather Bureau.—R. S. Woodward (chairman), Cleveland Abbe, W. W. Campbell, Arthur L. Day, E. L. Nichols, E. C. Pickering, Ira Remsen, Elihu Thomson, C. R. Van Hise, W. H. Welch, ex officio.

Committee on William Ellery Hale lectureship.—George E. Hale (chairman), E. G. Conklin, Arthur L. Day, A. A. Noyes, H. F. Osborn, E. B. Wilson.

Committee to consider advisability of publication by the academy of some form of journal.—A. A. Noyes (chairman), E. G. Conklin, Arthur L. Day, George E. Hale, Charles S. Minot, R. S. Woodward.

Committee on research and trust funds.—Charles S. Minot (chairman), Whitman Cross, Arnold Hague, A. A. Noyes, E. C. Pickering, Ira Remsen, Arthur G. Webster.

Committee on publication.—William H. Welch (chairman), Charles D. Walcott, Arthur L. Day.

Finance committee.—Whitman Cross, Theodore N. Gill, Charles D. Walcott.

INTERNATIONAL ASSOCIATION OF ACADEMIES.

The following recommendations were offered by the council and adopted by the academy:

(1) Upon telegraphic request from the foreign secretary: That the academy vote affirmatively on the admission of the academies of Edinburgh and Helsingfors to membership in the International Association of Academies.

THE MORRIS LOEB BEQUEST.

(2) Resolutions upon the bequest of $2,500 from the estate of Mr. Morris Loeb, of New York.

Whereas the executors of the estate of Morris Loeb, of New York, have placed in the hands of the treasurer of the National Academy of Sciences the sum of two thousand five hundred dollars, for the purpose declared by him in his last will and testament, as follows:

"I give and bequeath to the National Academy of Sciences in Washington, in the District of Columbia, the sum of two thousand five hundred dollars as a contribution toward the Wolcott Gibbs fund, founded in 1892."

Resolved, That the National Academy of Sciences accepts the bequest of two thousand five hundred dollars made to the academy by Morris Loeb, of New York, together with the condition that it be added to the capital of the Wolcott Gibbs fund in accordance with the will of the donor. That the trustees of the Wolcott Gibbs fund are instructed to carry into effect this condition and to administer the income as in the case of other income from that fund.

Resolved, That the National Academy of Sciences, desiring to make appropriate expression of its appreciation of this generous donation in the interest of science and the recognition of the work of Wolcott Gibbs, directs that this resolution be engrossed and a copy thereof be transmitted to Mrs. Loeb by the home secretary.

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PRESIDENT'S REPORT ON THE RECOMMENDATION FOR CHIEF OF THE WEATHER BUREAU.

The president reported to the academy the recommendations of the committee appointed to aid the Secretary of Agriculture in the choice of a chief of the United States Weather Bureau as follows:

DR. WM. H. WELCH,
807 St. Paul Street, Baltimore, Md.

MY DEAR MR. WELCH: I have just been informed that you have been elected president of the National Academy of Sciences. Permit me to congratulate you on this honor.

This position makes you an official adviser of the Government, and therefore of the Secretary of Agriculture, one of the officers of the Government. * * *

As you doubtless know, the position of Chief of the Weather Bureau is vacant. Our desire is to discover the best available scientist in the country for the position. He should at least have a thorough foundation in the sciences related to meteorology, sound judgment, and excellent administrative ability. I shall very much appreciate it if you will have suggested to me a number of names of suitable men and have such information furnished me as may be needed for my guidance. * * *

Assuring you of our earnest desire to have your cooperation, I am,

Faithfully yours,

(Signed) D. F. HOUSTON,
Secretary.

In discussing the requirements of the position and the qualifications of possible candidates therefor the committee was guided by the following general considerations:

1. A combination of scientific and executive abilities is essential.
2. No candidate upward of 60 years of age should be considered.
3. Other things equal, a man who has already had experience in the service of the Weather Bureau should be preferred.
4. The ideal man for the position is one who has the requisite scientific and executive abilities and who is still young enough to make a career in the bureau.

In addition to these considerations it is the unanimous opinion of the committee that in the interests alike of the United States Government and of meteorological science the position in question should be removed as soon as practicable from the category of political appointments.

After carefully weighing in the light of the above criteria all evidence in respect to the names available to the committee, the name of Prof. C. F. Marvin was recommended.

Prof. Marvin has been professor of meteorology in the Weather Bureau since 1891. During his long term of service in the Weather Bureau, dating from 1884, his work has been distinguished by high merit. As chief of the instrument division he has invented, perfected, and standardized many new instruments. He has made very few, if any, mistakes in theory or in practice. He is known not only as a trustworthy man of science, but also as a man of the highest fidelity to the interests of the Government.

This shows a wide range of activity on his part and a very comprehensive knowledge of the work of the Weather Bureau.

Assuming that the Weather Bureau must ultimately become a branch of the public service entirely removed from political influences, it is believed by the committee that the man recommended above, if appointed to the position in question, will be able to conduct the work of the bureau, now of vast importance to agriculture and to commerce, with an efficiency and with an economy which will command the approval of the Government and the respect of the representatives of the peculiarly international science of meteorology.

Very respectfully submitted, for the committee, by

R. S. WOODWARD, *Chairman.*

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MEDAL FOR EMINENCE IN THE APPLICATION OF SCIENCE TO THE PUBLIC WELFARE.

The committee on the establishment of a medal for eminence in the application of science to the public welfare reported that a letter had been received from Mrs. Helen Hartley Jenkins, offering a gift of $2,000, to constitute a fund to be called, in honor of her father, the Marcellus Hartley fund, to defray the expenses of an appropriate medal to be awarded for eminence in the application of science to the public welfare. The committee also submitted a design for this medal prepared by Mr. T. Spicer-Simson.

The committee recommended that Mrs. Jenkins's kind offer be accepted, and the medal established, and further that the design furnished by Mr. Spicer-Simson be adopted.

It was moved that the report of the committee be adopted, and that a suitable acknowledgment of the gift of the Marcellus Hartley fund be made to the donor, Mrs. Helen Hartley Jenkins. Adopted unanimously.

The president thereupon appointed the following committee on the medal for eminence in the application of science to the public welfare: Elihu Thomson, chairman, George F. Becker, William F. Hillebrand, Henry Fairfield Osborn, Michael I. Pupin, Arthur G. Webster, William H. Welch.

At the adjourned meeting on November 19 the president reported a recommendation from the committee on the medal for eminence in the application of science to the public welfare, supported by a recommendation from the council, that two awards of the medal be made by the academy at the annual meeting in 1914 to William Crawford Gorgas and to George Washington Goethals, for distinguished services in connection with the building of the Panama Canal. The recommendation was adopted unanimously.

REPORT OF THE COMMITTEE ON RESEARCH AND TRUST FUNDS.

Mr. Minot presented the following report from the committee on trust funds:

REPORT OF PROGRESS OF THE COMMITTEE ON RESEARCH AND TRUST FUNDS.

1. The committee recommends that a record of each grant and award be kept on file by the home secretary, who shall be furnished the necessary competent clerical assistance.

2. Each record to be on a separate sheet and to include the following items:
   1. Name of the fund.
   2. Date and number of the grant or award.
   3. Amount of the grant and date of payment.
   4. Name and address of recipient.
   5. Subject investigated.
   6. Brief annual reports of progress and a general statement of expenditures.
   7. List of resulting publications.

3. Each committee to be requested, or, when in the power of the academy, be required to transmit to the president annually before the annual meeting a written report on all new and outstanding grants.

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4. A suitable summary of these reports to be included in the annual report to Congress.

5. The records kept by the home secretary to be accessible to all the committees in charge of the research funds.

6. All apparatus and materials purchased with money from the grants and not used up in the course of the investigations to remain the property of the academy, and to be delivered to the academy at the close of each investigation or upon demand.

7. In the case of committees appointed by the academy, no appointment to be made for a term longer than six years. This recommendation is not intended to prohibit reappointments.

Each committee to consist usually of not more than five members. The terms of appointments to be such that the term of not more than one member shall terminate in any one year.

8. The council to report to the academy such changes as are necessary in the constitution or rules to render these recommendations effective.

The report was adopted as read.

The folowing resolutions were adopted:

ANNUAL DINNER, 1914.

That the annual dinner of the academy held at the time of the annual meeting be in honor of the retiring president and home secretary.

PERMANENT BUILDING.

That the council be requested to report at the next annual meeting on a permanent building for the academy.

REPORT OF THE SPECIAL COMMITTEE ON THE PUBLICATION OF A JOURNAL BY THE ACADEMY.

The special committee appointed to report on the advisability of the publication by the Academy of some form of journal respectfully submits the following report:

The committee, believing that the question of the publication of a journal can be satisfactorily considered only after a fairly definite plan has been formulated, has taken up in some detail the more important aspects of the matter; and it presents in the following paragraphs the information it has gathered and the provisional conclusions it has reached.

Name of the journal.—The appropriate name would seem to be "Proceedings of the National Academy of Sciences," since the publication of "Proceedings" is provided for in the constitution of the academy, and since the journals of nearly all academies are called proceedings.

Character of the journal.—The journal or proceedings might well consist mainly of original publications of the researches of members of the Academy and of other American investigators whose work is presented by a member and approved for publication by the editors of the "Proceedings." The committee believes that as a rule the papers should not consist, as do many of those published in the Comptes Rendus of the French Academy, of conclusions presented in condensed form without experimental evidence, nor of preliminary notices published merely for securing priority or reserving the field; but that, on the other hand, the papers should not be so long nor so detailed as those appropriately published in journals devoted to the special branches of science. The papers should always be precise, and should contain some record of the experimental or observational results wherever required for the substantiation of important conclusions; but these results should be given in condensed summaries, reserving long tables of data and other minutiae of the work for subse-

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quent publication in special journals. Such subsequent publication should be permitted and encouraged. Plates and elaborate illustrations should not be provided for, but zinc etchings and halftones might be included when essential.

Plan of publication.—It would seem best to issue the proceedings monthly, and to provide at the start for the publication of about 1,000 pages a year. The committee believes that the proceedings should be in charge of an editor, who would be assisted by a committee or editorial board consisting of one or more members belonging to each of the committees into which the academy is divided, and who would be relieved of routine editorial work by the employment of an assistant secretary.

Cost of publication.—Information that the committee has received in regard to the publication of a similar journal indicates that the cost of printing and distributing 1,000 to 1,500 copies of the proceedings, not including any payment for editing and managing, would not exceed $4 a page, or $4,000 a year if the proceedings should consist of 1,000 pages.

Means of financing the publication.—The income of the Academy for the year 1912 from its funds available for general purposes and from membership dues was $3,423, and the general expenses of the academy for that year were $2,041, leaving a balance of $1,382 available for other purposes, such as the publication of a journal.

It has been suggested that certain of the research funds of the Academy are also available for the publication of researches in the fields to which the funds pertain, and the committee believes that it would be appropriate to invite the trustees of the various research funds administered by the Academy to consider the allotment of a portion of the income for the publication of the researches supported from these funds, and of such other researches as the members of the Academy may desire to publish therein.

Since the general funds of the academy are inadequate, some further provision for the expense of publication of the proceedings will have to be made. It is the opinion of a majority of the committee that an effort should first be made to secure the passage by Congress of an act providing for the printing of the proceedings by the Government, in addition to the printing of the annual report and the scientific memoirs of the Academy already authorized by an existing act of Congress.

If it should prove impracticable to secure the passage of such an act by Congress, another alternative is to raise by subscription a guarantee fund of $1,500 to $2,000 a year for a period of five years to supplement the funds of the Academy available for the publication of the proceedings. A provisional offer of $1,000 per year for this purpose has already been received by the committee. At some later date the Joseph Henry fund, the income from which is likely to be about $2,000, will be available for the same purpose. An increase in the annual dues of the academy from $5 to $10, yielding about $650 more, might also receive consideration as a means of meeting a part of the cost of publication.

Distribution of the proceedings.—The proceedings might well be sent free to members of the academy, to the libraries of all the prominent academies, to certain other important libraries, and to editors of the leading abstract journals in various branches of science. The privilege of subscribing to the proceedings should be open to any person or institution. Especial efforts should be made, under the direction of the foreign secretary, to secure an adequate foreign distribution of the proceedings, so as to bring American work more fully to the attention of foreign scientists.

Public announcements of researches presented to the Academy.—Abstracts of many of the papers presented to and accepted by the Academy might well be prepared and published in Science immediately after the acceptance of the papers or simultaneously with their appearance in the monthly numbers of the proceedings. Abstracts of such papers as can be made of popular interest might also be issued to the Associated Press on the day on which the monthly number appears.

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Advantage of the publication of proceedings.—The most important of the advantages to be derived from the publication of the proceedings is the service it would render to American science. It would create a journal of national scope and standing which might well furnish a fairly complete record of the important contributions to all branches of science made by American investigators. It would thereby serve to make American research more promptly and more fully known to the scientific men of other nations, and it would bring to the attention of the scientific men of this country the important work done in other fields than their own.

The advantages that would come to the Academy itself from the publication of a suitable journal are of secondary, but by no means of inconsiderable importance, for the fuller development of the Academy as the national organization representing American research ought to contribute in large measure to the advancement of American science. Some of the advantages that would result to the Academy from rendering this new service would seem to be a fuller recognition of the importance of the Academy by scientific men and public men at home and abroad, the establishment of closer relations between members of the academy by making known to them the work of their associates, and the securing by exchange of many valuable publications whereby an academy library might be developed.

Recommendations.—In view of the foregoing considerations, the committee recommends that the academy adopt a resolution favoring the publication of proceedings of the general character set forth in this report; and, if this be approved by the Academy, the committee further recommends that the matter be referred to the council with power to arrange for the publication of proceedings as soon as adequate means of financing the publication shall have been secured.

A. A. Noyes, G. E. Hale,
E. G. Conklin, C. S. Minot,
Arthur L. Day, R. S. Woodward.

The academy then adopted the following resolution:

That the report of the committee on the establishment of a journal be adopted and referred to the council with power to act.

SCIENTIFIC SESSIONS.

NOVEMBER 18.

T. H. Morgan: The constitution of the chromosomes as indicated by the heredity of linked characters.

H. McL. Evans (introduced by F. P. Mall): The action of vital stains belonging to the benzidine group.

S. O. Mast (introduced by W. H. Howell): Changes in pattern and color in fishes, with special reference to flounders.

D. S. Johnson (introduced by W. H. Howell): The perennating fruits of the prickly pears.

B. F. Lovelace (introduced by H. N. Morse): A static method for the measurement of vapor pressures of solutions.

S. Weir Mitchell: Biographical memoir of Dr. John S. Billings.

NOVEMBER 19.

Simon Flexner: Some factors in the epidemiology of infection.

Knigh Dunlap (introduced by W. H. Welch): The fusion of successive flashes of light.

L. B. Mendel: Factors relating to the rôle of the inorganic components of the diet.

H. A. Kelly (introduced by W. H. Welch): Radio-therapeutics in surgical affections.

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A. H. Pfund (introduced by J. S. Ames): Measurement of stellar radiation.
J. A. Anderson (introduced by J. S. Ames): A method for testing screws.
J. B. Watson (introduced by W. H. Welch): An experimental study of homing.
G. F. Becker: Planetary rotation.
G. F. Becker and A. L. Day: Fresh experiments on the linear force of growing crystals.
A. G. Webster: A new portable phonometer.
L. V. King (introduced by A. G. Webster): Phonometric characteristics of fog-signal equipment.
H. F. Reid: Sea waves due to earthquakes.
A. G. Webster: The transmission of sound through porous materials.
C. B. Davenport: Absence of correlation between curliness of the hair and color of the skin in offspring of negro-white crosses.

PAPERS READ BY TITLE.

W. M. Davis: Biographical memoir of John Wesley Powell.
H. F. Osborn: Final results on the phylogeny or lines of descent in the Titanotheres.
H. C. Jones (introduced by Ira Remsen): The absorption of light by water containing strongly hydrated salts.

BIOGRAPHICAL NOTICES.

SIR GEORGE HOWARD DARWIN, K. C. B., F. R. S.

George Howard Darwin, who died at Cambridge on Saturday, December 7, 1912, was born in 1845 at Down, and was the second son of Charles Darwin, author of "The Origin of Species." He was educated under the Rev. Charles Pritchard, who subsequently became a fellow of the Royal Society and the Savilian professor of astronomy at Oxford. In 1864 Darwin entered Trinity College, Cambridge, from which he was graduated in 1868 as second wrangler and second Smith's prizeman. He was elected a fellow of Trinity in the same year, and enjoyed the statutory tenure of 10 years. In addition to mathematical subjects, he was interested in economic and political science, and with a view to practical life secured admission to the bar in 1874, but he did not subsequently practice that profession. On account of ill health he returned to Cambridge about this time and devoted himself to mathematical science, especially in its astronomical applications.

He was associated with Lord Kelvin in his work and rewrote the second edition of the large section of Thompson and Tait's "Natural Philosophy," which deals with tides and their cosmical relations. He was elected to the Plumian professorship of astronomy at Trinity in 1884. In 1898 he supplemented "Natural Philosophy" by publishing a nonmathematical treatise on the tides and kindred phenomena in the solar system; and a new edition of this work, in part rearranged to include recent developments, was in preparation at the time of his death. His studies in astronomical evolution culminated in the extensive memoir "Acta Mathematica" in 1896. The Royal Society nominated him a member of the Meteorological

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Council soon after his return to Cambridge, and later, when that council was reorganized as a committee under the Treasury, he became one of the two representatives which the Royal Society was requested to nominate to the new body, and continued to render valuable service in that capacity. It was on the retirement of Sir George Stokes that Darwin became the adviser and referee in the great trigonometrical survey of India. The foreign office, on the advice of the Royal Society, appointed him as representative to the International Geodetic Association, and its work became a part of his life. He continued to take great interest in the University of Cambridge, and was a member of the Cambridge University Association.

In recognition of his contributions to science he was elected a foreign associate of the National Academy of Sciences at its annual meeting in April, 1904.

As a crowning honor to a life devoted to scientific pursuits, he received the Copley medal, awarded by the Royal Society in 1911, and his last appearance was as president of the Fifth International Congress of Mathematicians, which met at Cambridge on August 22–28, 1912.

Prof. Darwin's published contributions to scientific literature include papers on consanguineous marriages, for the Statistical Society; jointly with his brother, on Small Deflections of the Plumb Line Due to Movement of the Earth, British Association report; a series of reports to the British Association on Harmonic Analysis of Tidal Observations, 1883 and later; several papers on the same subject in the Proceedings of the Royal Society; a series of memoirs on the Effects of Tidal Friction on the Earth and on the Moon, Philosophical Transactions of the Royal Society; papers on subjects cognate to the last, and on Figures of Equilibrium of Rotating Masses of Fluid and on the Mechanical Constitution of a Swarm of Meteorites, Philosophical Transactions of the Royal Society; a paper on Periodic Orbits, in 1896; and one on the Tides and Kindred Phenomena in the Solar System, 1898.

JOHN SHAW BILLINGS.

John Shaw Billings was born in Switzerland County, Ind., April 12, 1838, and died of pneumonia following a serious operation on the 11th of March, 1913. He was graduated from Miami University in 1857; A. M., 1860. Hospital service gave him what the imperfect medical education of that day did not give, and as demonstrator of anatomy he prepared himself for surgical practice, which found its opportunities in the clinics of the battlefield. He was commissioned assistant surgeon, United States Army, in April, 1862. In 1866

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he became surgeon captain; in 1876 surgeon major, and in 1890 colonel and Deputy Surgeon General. He was retired from active service in 1895, at his own request, by President Cleveland, and became professor of hygiene in the University of Pennsylvania.

During his Army service he began very early to exhibit his constructive talent in altering or building hospitals, and his remarkable power of administrative command in these vast homes of the sick and wounded.

During his career as a surgeon in the years before 1895 he became an authority on military medicine and public hygiene, and was one of five who submitted in 1875, by request, plans for the construction of the Johns Hopkins Hospital. His careful study of the conditions required in a hospital were accepted, and included many very original changes from the organization and construction found in hospitals of that period. He also supervised the planning and construction of the Barnes Hospital of the Soldiers Home in Washington, D. C., and later the buildings of the Army Medical Museum and the Surgeon General's Library.

The great work of John Shaw Billings, which gave him finally a world-wide repute, began some time after 1864, when he was asked by the Surgeon General, to take charge of the Army Medical Museum Library created under Surg. Gen. Hammond, and now the most completely useful collection of medical works in the world. When he took hold of this work the Surgeon General's Library contained a little over 1,000 volumes. When he gave up this charge at the time of his appointment to the chair of hygiene in the University of Pennsylvania, the library contained 307,455 volumes and pamphlets and 4,335 portraits of physicians. The Index Medicus was begun by Dr. Billings and his able assistant, Dr. Robert Fletcher, in 1879, as an extra-official publication, supplementary to the index catalogue of the Army Medical Museum. It was also here that Dr. Billings obtained his training for the still larger task which awaited him when he was chosen as librarian of the Astor-Tilden-Lenox Library in New York City.

Throughout his life he was a busy writer of essays on hygiene, hospital construction and administration, the statistics of war, and addresses or essays, such as his History of Surgery, which is perhaps the best presentation of this subject ever made.

He served as a member of the board of trustees of the Carnegie Institution of Washington, and of its executive committee, from its foundation to the time of his death.

He was nominated for membership in the National Academy of Sciences in 1883, his claim to this high distinction being founded by his friends upon his application of skill in the scientific classification

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of books and of the medical knowledge of his profession throughout the centuries. No medical librarian who ever lived had up to that time shown such an almost instinctive capacity for the scientific classification of knowledge so as to make it readily available.

He rendered efficient service as treasurer of the academy from 1887 to 1889, and served on eight important committees of as a member of our council.

Numberless presidencies of societies fell to his share, and the list of his honorary titles from all of the greater academies and universities, at home and abroad, served to show in what esteem he was held by men of science.

Throughout his modest life of the labor he loved, he accepted grave burdens and whatever duties, official or other, fell to him, apparently indifferent to praise or popular reputation, while he dealt victoriously with tasks so various in their nature that any one of them would have sufficed to tax the technical competence of the most able man.

(Extract from the "Memoir of John Shaw Billings," by S. Weir Mitchell.)

ANNUAL REPORT OF THE TREASURER.

January 1 to December 31, 1913.

To the PRESIDENT OF THE NATIONAL ACADEMY OF SCIENCES:

SIR: I have the honor to submit the following report as treasurer for the fiscal year, January 1 to December 31, 1913. In advance of its detailed statements it may be of interest to present a general review of the year's financial transactions.

The income of the academy during the year, from dues and investments, including subscriptions to the semicentennial fund, was $13,641.58; the expenditures, exclusive of investments, $18,191.41.

The sum of investments held by the academy on December 31 was $227,353.10 (price paid), with an average return of 4.96 per cent. The total income from investments received during the year was $10,776.25.

Changes in investments may be summarized as follows: Two first-mortgage notes on real estate, amounting to $10,000, were paid in full, and one note was curtailed by the payment of $1,000; two $1,000 bonds, representing income of the general fund, were sold; bonds were purchased to the amount of $15,602.50 (face value, $16,000).

The Wolcott Gibbs fund was increased by the payment of a bequest of $2,500 from the late Morris Loeb, of New York City. This raises the capital of the Gibbs fund to $5,500.

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A donation of $1,500 was received from Mrs. Helen Hartley Jenkins, of New York City, toward a fund to be known as the Marcellus Hartley fund, to provide and maintain a medal of the academy for eminence in the application of science to the public welfare.

The Comstock fund has been increased by the transfer of $966.12, the balance of accumulated income remaining after the award of the Comstock prize in April, 1913.

The special fund subscribed by members and friends of the academy to meet the extraordinary expenses of the celebration of the semicentennial, in April, 1913, amounted to $3,645, exclusive of dinner subscriptions, of which $3,445 was contributed by members of the academy. The small balance of this fund will be applied toward the expense of the volume containing the record of the anniversary meeting.

The expense of "A history of the first half century of the National Academy of Sciences 1863–1913" was met from the general fund.

Payments made on grants from various funds, in aid of research, amounted to $4,520.65; for medals awarded at the April meeting, $515.38; for prizes given at the same time, $1,600.

There were received December 31, too late for deposit, three checks for dues, amounting to $15, and one subscription for annual dinner, $5.

The report contains a condensed statement of receipts and expenditures, a statement of assets and liabilities, and an account with each individual fund for the year 1913.

CONDENSED STATEMENT OF RECEIPTS AND EXPENDITURES—1913.

RECEIPTS.

Balance January 1, 1913 as per last report		$8,894.74
Total income from investments during 1913		10,776.25
Accrued interest, account changes in investments		114.33
Interest on bank deposits		183.86
Morris Loeb bequest, Wolcott Gibbs fund		2,500.00
Public welfare medal, subscription toward a special fund		100.00
Marcellus Hartley fund		1,500.00
Mortgage notes paid and bonds sold		13,020.00
Investments transferred		2,000.00
Advance to Murray fund returned		151.05
Annual dues:		
1911	$5.00	
1912	30.00	
1913	625.00	
		660.00
American Express Co., overcharge return		.19
Subscriptions to semicentennial fund		2,090.00
		41,990.42

EXPENDITURES.

Investments transferred	$2,000.00
Investments of capital	13,677.50
Investment of income	1,925.00
Accrued interest, account changes in investments	202.28

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Warrants on trust funds:		
Bache fund—		
B. Osgood Pierce	$500.00	
R. M. Yerkes	500.00	
Franklin D. Barker	150.00	
Carl O. Johns	150.00	
J. Vôute	200.50	
P. W. Bridgman	500.00	
Gilbert N. Lewis	500.00	
Comstock fund—		
Prize	1,514.00	
Draper fund—		
Medal	216.38	
Murray fund—		
Agassiz medal	626.05	
Smith fund—		
George P. Merrill	400.00	
C. C. Trowbridge	250.00	
Watson fund—		
A. O. Leuschner	970.15	
Mrs. A. H. Watson	200.00	
J. C. Kapteyn, prize	100.00	
J. C. Kapteyn, medal	135.00	
Marcellus Hartley fund—		
Design for medal	1,000.00	
Public Welfare Medal, subscription returned	100.00	
		$8,012.06
General expenses:		
Semicentennial celebration	3,653.75	
General fund:		
Salary, assistant secretary and treasurer, 12 months	600.00	
Treasurer's office (auditing, bond, printing, etc.)	187.35	
Home secretary's office (clerical help, printing minutes, lists of members, circulars, etc.)	660.53	
Semicentennial volume	3,133.61	
Biographical memoirs, printing	372.10	
Agassiz medal advance from general fund	747.00	
Annual tables of constants	200.00	
Annual meeting—		
Council dinner, etc	18.00	
Fall meeting	68.00	
International Association of Academies dues	38.81	
Postage	122.40	
Election of members (printing, diplomas, etc.)	175.50	
		9,977.05
Cash balance in bank, Dec. 31, 1913: [1]		
Cash income balance December 31, 1913		5,451.96
Uninvested capital December 31, 1913		744.55
		41,990.42

Unpaid dues: 1912, $5; 1913, $20; total, $25.

[1] Five outstanding checks, $142.02.

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STATEMENT OF ASSETS AND LIABILITIES, DEC. 31, 1913.

ASSETS.

1. Mortgage notes, secured by first mortgage on real estate		$121,250.00
2. Bonds, giving name, face value, rate of interest, and cost:		
Alberta bonds, $2,600, 4½ per cent	$2,502.50	
Broadway Realty Co., $10,000, 5 per cent	10,355.00	
Bush Terminal Buildings Co., $10,000, 5 per cent	9,850.00	
Chesapeake & Ohio, $5,000, 4½ per cent	4,556.25	
City of Tacoma, Green River gravity system, $4,000, 5 per cent	4,150.60	
Cleveland Electric Illuminating Co., $5,000, 5 per cent.	5,100.00	
Cosmos Club, $21,000, 4½ per cent	21,000.00	
Detroit Edison Co., $6,000, 5 per cent	6,150.00	
Dominion Coal Co., $5,000, 5 per cent	5,000.00	
Georgia Railway & Electric Co., $2,000, 5 per cent	2,060.00	
Milwaukee Railway & Electric Light Co., $3,000, 5 per cent	2,700.00	
Minneapolis General Electric Co., $3,000, 5 per cent	3,030.00	
Niagara Falls Power Co., $4,000, 5 per cent	4,100.00	
Riggs Realty Co., $20,000, 5 per cent	20,705.00	
Southern Bell Telephone & Telegraph Co., $5,000, 5 per cent	4,843.75	
		106,103.10
3. Bank balance, Dec. 31, 1913 [1]		6,196.51
		233,549.61

LIABILITIES.

	Income.	Capital.
General fund:		
Invested	$4,210.00	
Uninvested	1,147.37	
Agassiz fund:		
Invested		$50,000.00
Uninvested		
Bache fund:		
Invested	2,575.00	55,932.95
Uninvested	1,120.23	67.05
Building fund:		
Invested	1,077.50	7,000.00
Uninvested	39.79	
Comstock fund:		
Invested	226.38	11,281.12
Uninvested	81.50	22.50
Draper fund:		
Invested	2,035.00	10,000.00
Uninvested	943.33	
Gibbs fund:		
Invested		5,472.50
Uninvested	345.59	27.50
Gould fund:		
Invested	4,567.50	20,000.00
Uninvested	1,039.24	
Marsh fund:		
Invested	192.50	9,377.65
Uninvested	104.65	

[1] Five outstanding checks, $142.02.

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	Income.	Capital.
Murray fund:		
Invested		$5,965.00
Uninvested		35.00
Smith fund:		
Invested	$1,532.50	9,985.00
Uninvested	401.58	15.00
Watson fund:		
Invested	1,000.00	24,922.50
Uninvested		77.50
Marcellus Hartley fund		500.00
Semicentennial special fund: Uninvested	258.75	
Total	22,898.41	210,681.27
		22,898.41
		233,579.68
Watson fund: Income overdraft		30.07
		233,549.61

ACCOUNT WITH INDIVIDUAL FUNDS JAN. 1, 1913, TO JAN. 1, 1914.

	General fund.		Agassiz fund.		Bache fund.	
	Income.	Capital.	Income.	Capital.	Income.	Capital.
Balance Jan. 1, 1913:						
Cash	$811.08				$664.57	$14.55
Invested	7,210.00			$50,000.00	2,575.00	55,985.45
Receipts:						
Interest on investments	2,732.44				2,956.16	
Accrued interest	114.33					
Interest on deposits	183.86					
Profit on sale of bonds	20.00					
Dues:						
1911	5.00					
1912	30.00					
1913	625.00					
Express overcharge	.19					
Murray fund advance	151.05					
Total	11,882.95			50,000.00	6,195.73	56,000.00
Disbursements:						
Warrants on funds	200.00				2,500.50	
General expenses	5,527.35					
Murray fund advance	595.95					
Accrued interest	202.28					
Balances Dec. 31, 1913:						
Cash	1,147.37				1,120.23	67.05
Invested	4,210.00			50,000.00	2,575.00	55,932.95
Total	11,882.95			50,000.00	6,195.73	56,000.00
Mortgage notes paid				1,000.00		8,500.00
Bonds transferred	1,000.00					
Bonds sold	2,020.00					
Investments made				1,000.00		8,447.50

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ACCOUNT WITH INDIVIDUAL FUNDS JAN. 1, 1913, TO JAN. 1, 1914—Continued.

	Comstock fund.		Draper fund.		Gibbs fund.	
	Income.	Capital.	Income.	Capital.	Income.	Capital.
Balance Jan 1, 1913:						
Cash	$205.12	$87.50	$1,095.90	.....	$162.08	.....
Invested	2,000.00	10,250.00	1,535.00	$10,000.00	.....	$3,000.00
Receipts:						
Interest on investments	582.88	.....	568.81	.....	182.51	.....
Morris Loeb bequest	.....	.....	.....	.....	.....	2,500.00
Increase of Comstock fund	.....	966.12	.....	.....	.....	.....
Total	2,788.00	11,303.62	3,194.71	10,000.00	345.59	5,500.00
Disbursements:						
General expenses	14.00	.....	13.00	.....	.....	.....
Medal	.....	.....	208.33	.....	.....	.....
Prize	1,500.00	.....	.....	.....	.....	.....
Increase of Comstock fund	966.12	.....	.....	.....	.....	.....
Balances Dec. 31, 1913:						
Cash	81.50	22.50	943.38	.....	345.59	27.50
Invested	226.38	11,281.12	2,035.00	10,000.00	.....	5,472.50
Total	2,788.00	11,303.62	3,194.71	10,000.00	345.59	5,500.00
Mortgages notes paid	1,000.00	.....	.....	.....	.....	500.00
Mortgages notes transferred	1,000.00	.....	500.00	.....	.....	.....
Investments made	192.50	1,065.00	.....	.....	.....	2,972.50

	Gould fund.		Marsh fund.		Murray fund.	
	Income.	Capital.	Income.	Capital.	Income.	Capital.
Balance, Jan. 1, 1913:						
Cash	$893.41	.....	$46.96	.....	$326.05	$35.00
Invested	3,605.00	$20,000.00	.....	$9,377.65	.....	5,965.00
Receipts:						
Interest on investments	1,108.33	.....	250.19	.....	300.00	.....
Total	5,606.74	20,000.00	297.15	9,377.65	626.05	6,000.00
Disbursements:						
Agassiz medal	.....	.....	.....	.....	475.00	.....
Repayment on account, Agassiz medal	.....	.....	.....	.....	151.05	.....
Balances Dec. 31, 1913:						
Cash	1,039.24	.....	104.65	.....	.....	35.00
Invested	4,567.50	20,000.00	192.50	9,377.65	.....	5,965.00
Total	5,606.74	20,000.00	297.15	9,377.65	626.05	6,000.00
Investments made	962.50	.....	192.50	.....	.....	.....

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ACCOUNT WITH INDIVIDUAL FUNDS JAN. 1, 1913, TO JAN. 1, 1914—Continued.

	Smith fund.		Watson fund.		Semicentennial fund.	
	Income.	Capital.	Income.	Capital.	Income.	Capital.
Balance Jan. 1, 1913:						
Cash	$506.58	$15.00	$1,169.55	$270.00	$1,822.50	
Invested	1,532.50	9,985.00		24,730.00		
Receipts:						
Interest on investments	545.00		1,205.53			
Semicentennial subscriptions					2,090.00	
Total	2,584.08	10,000.00	2,375.08	25,000.00	3,912.50	
Disbursements:						
Warrants	650.00		1,170.15			
General expenses					3,653.75	
Medal			135.00			
Prize			100.00			
Balances, Dec. 31, 1913:						
Cash	401.58	15.00		77.50	258.75	
Invested	1,532.50	9,985.00	1,000.00	24,922.50		
			2,405.15			
Overdraft			30.07			
Total	2,584.08	10,000.00	2,375.08	25,000.00	3,912.50	
Bonds transferred			1,000.00			
Investments made				192.50		

	Building fund.		M. Hartley fund.	
	Income.	Capital.	Income.	Capital.
Balance Jan. 1, 1913:				
Cash	$768.89			
Invested		$7,000.00		
Receipts				
Interest on investments	348.40			
Public welfare medal				$100.00
Marcellus Hartley fund				1,500.00
Total	1,117.29	7,000.00		1,600.00
Disbursements:				
Return of first subscription public welfare medal				100.00
Design for medal				1,000.00
Balances Dec. 31, 1913:				
Cash	39.79			500.00
Invested	1,077.50	7,000.00		
Total	1,117.29	7,000.00		1,600.00
Mortgage notes transferred	500.00			
Investments made	577.50			

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COMBINED STATEMENT, INDIVIDUAL FUNDS.

	Income.	Capital.	Total.
Balance Jan. 1, 1913:			
Cash	$3,472.69	$422.05	$3,894.74
Invested	18,457.50	206,298.10	224,750.60
Receipts:			
Interest on investments	10,776.25		
Accrued interest	114.33		
Interest on deposits	183.86		
Profit on sale of bonds	20.00		
Annual dues—			
1911	5.00		
1912	30.00		
1913	625.00		
Express overcharge	.19		
Murray fund advance	151.05		
Semicentennial subscriptions	2,090.00		13,995.68
Increase of Comstock fund		966.12	966.12
Increase of Gibbs fund		2,500.00	2,500.00
Public welfare medal		100.00	
Marcellus Hartley fund		1,500.00	1,600.00
Total			252,707.14
Disbursements:			
Warrants on funds	4,520.65		
General expenses	9,208.10		
Accrued interest	202.28		
Murray fund advance (General fund)	595.95		
Agassiz medal	626.05		
Draper medal	208.38		
Watson medal	135.00		
Watson prize	100.00		
Comstock prize	1,500.00		17,091.41
Return of subscription to public welfare medal		100.00	
Design public welfare medal		1,000.00	1,100.00
Increase of Comstock fund			966.12
Balances Dec. 31, 1913:			
Cash	5,451.96	744.55	6,196.51
Invested	17,416.38	209,936.72	227,353.10
Total			252,707.14
Mortgage notes paid		11,000.00	
Notes and bonds transferred	2,000.00		
Bonds sold	2,020.00		
Investments made	1,925.00	13,677.50	

Respectfully submitted.

WHITMAN CROSS, *Treasurer.*

JANUARY 15, 1913.

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REPORT OF THE AUDITING COMMITTEE.

WASHINGTON, D. C., *January 24, 1914.*

We hereby certify that we have examined the securities and papers contained in the box of the National Academy of Sciences at the American Security & Trust Co.'s building and have found them to correspond with the list furnished by the treasurer, and to differ because of the sale and purchase of bonds and mortgage notes as shown by the report of the certified accountant. We find that the coupons due in 1913 have been cut and are accounted for; also that the coupons due January 1, 1914, have been detached and are accounted for by an appropriate entry in the pass book. We have accepted the certified statement of William L. Yaeger, public accountant, as to the correspondence between the vouchers, pass book, and accounts of the treasurer and as to the balance shown by the books of the treasurer on December 31, 1913, and certify to its agreement with the balance shown by the report of the treasurer by his check book and by the American Security & Trust Co.

WM. H. DALL.
F. W. CLARKE.
ARTHUR L. DAY.

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APPENDICES.

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APPENDIX A.

CONSTITUTION OF THE NATIONAL ACADEMY.

As amended and adopted April 17, 1872, and further amended April 20, 1875; April 21, 1881; April 19, 1882; April 18, 1883; April 19, 1888; April 18, 1895; April 20, 1899; April 17, 1902; April 18, 1906; November 20, 1906; April 17, 1907; November 20, 1907; April 20, 1911; April 16, 1912.

PREAMBLE.

Empowered by the act of incorporation enacted by Congress, and approved by the President of the United States on the 3d day of March, A. D. 1863, and in conformity with the amendment to said act approved July 14, 1870, the National Academy of Sciences adopts the following amended constitution and rules:

ARTICLE I.—OF MEMBERS.

SECTION 1. The academy shall consist of members, honorary members, and foreign associates. Members must be citizens of the United States.

SEC. 2. Members who, from age or inability to attend the meetings of the academy, wish to resign the duties of active membership, may, at their own request, be transferred to the roll of honorary members by a vote of the academy.

SEC. 3. The academy may elect 50 foreign associates.

SEC. 4. Honorary members and foreign associates shall have the privilege of attending the meetings and of reading and communicating papers to the academy, but shall take no part in its business, shall not be subject to its assessments, and shall be entitled to a copy of the publications of the academy.

ARTICLE II.—OF THE OFFICERS.

SECTION 1. The officers of the academy shall be a president, a vice president, a foreign secretary, a home secretary, and a treasurer, all of whom shall be elected for a term of six years, by a majority of votes present, at the first stated meeting after the expiration of the current terms, provided that existing officers retain their places until their successors are elected. In case of a vacancy, the election for six years shall be held in the same manner at the meeting when such vacancy occurs, or at the next stated meeting thereafter, as the academy may direct. A vacancy in the office of treasurer or home secretary may,

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however, be filled by appointment of the president of the academy until the next stated meeting of the academy.

SEC. 2. The officers of the academy, together with six members to be elected by the academy, shall constitute a council for the transaction of such business as may be assigned to them by the constitution or the academy.

SEC. 3. The president of the academy, or, in case of his absence or inability to act, the vice president, shall preside at the meetings of the academy and of the council; shall name all committees except such as are otherwise especially provided for; shall refer investigations required by the Government of the United States to members especially conversant with the subjects and report thereon to the academy at its meeting next ensuing; and, with the council, shall direct the general business of the academy.

It shall be competent for the president, in special cases, to call in the aid, upon committees, of experts or men of special attainments not members of the academy.

SEC. 4. The foreign and home secretaries shall conduct the correspondence proper to the respective departments, advising with the president and council in cases of doubt, and reporting their action to the academy at one of the stated meetings in each year.

It shall be the duty of the home secretary to give notice to the members of the place and time of all meetings, of all nominations for membership, and of all proposed amendments to the constitution.

The minutes of each meeting shall be duly engrossed before the next stated meeting under the direction of the home secretary.

SEC. 5. The treasurer shall attend to all receipts and disbursements of the academy, giving such bond and furnishing such vouchers as the council may require. He shall collect all dues from members and keep a set of books showing a full account of receipts and disbursements. He shall present a general report at the annual meeting. He shall be the custodian of the corporate seal of the academy.

ARTICLE III.—OF THE MEETINGS.

SECTION 1. The academy shall hold one stated meeting in each year, called the annual meeting, in the city of Washington, beginning on the third Tuesday in April, and another, called the autumn meeting, may be held at such place and time as the council shall determine.

Special business meetings of the academy may be called, by order of eight members of the council, at such place and time as may be designated in the call.

Special scientific meetings of the academy may be held at times and places to be designated by a majority of the council.

SEC. 2. The names of the members present at each session of a meeting shall be recorded in the minutes, and the members present

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at any session shall constitute a quorum for the transaction of business.

SEC. 3. Scientific sessions of the academy, unless otherwise ordered by a majority of the members present, shall be open to the public; sessions for the transaction of business shall be closed.

SEC. 4. Stated meetings of the council shall be held during the stated or special meetings of the academy. Special meetings of the council may be convened at the call of the president and two members of the council, or of four members of the council.

SEC. 5. No member who has not paid his dues shall take part in the business of the academy.

ARTICLE IV.—OF ELECTIONS AND RESIGNATIONS.

SECTION 1. All elections shall be by ballot, and each election shall be held separately unless otherwise ordered by this constitution.

SEC. 2. The time for holding an election of officers shall be fixed by the academy at least one day before the election is held.

SEC. 3. The election of the six members of the council shall be as follows:

At the annual meeting in April, 1907, six members of the council to be elected, of whom two shall serve for three years, two for two years, and two for one year, their respective terms to be determined by lot. Each year thereafter the terms of two members shall expire, and their successors, to serve for three years, shall be elected at the annual meeting in each year.

SEC. 4. The academy shall be divided by the council into standing committees representing the principal branches of scientific research. A member may be assigned to more than one of these committees. The president of the academy shall appoint, subject to the approval of the council, a member of each committee as its chairman, who shall be responsible for the work of the committee.

Nominations to membership in the academy shall be made in writing, approved by a majority of the members of the committee on the branch of research in which the person nominated is eminent, or by a majority of the council in case there is no committee on the subject. The nominations shall be sent to the home secretary by the chairman of the committee before January 1 of the year in which the election is to be held, and each nomination shall be accompanied by a list of the principal contributions of the nominee to science. This list shall be printed by the home secretary for distribution among the members of the academy.

SEC. 5. Election of members shall be held at the annual meeting in Washington in the following manner: There shall be two ballots—a preference ballot, which may be prepared either before or at the annual meeting and must be transmitted to the home secretary, and a final ballot, to be taken at the meeting.

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Preference ballot.—Each member may inscribe on a ballot not more than 10 names of nominees selected from the submitted list. A list of the nominees shall then be prepared, on which the names shall be entered in the order of the number of votes received by each. In case two or more nominees should have the same number of votes on this preference list, the order in which they shall be placed on the list shall be determined by a majority vote of those present.

Final ballot.—A vote shall first be taken on the nominee who appears first on the preference list, and he shall be declared elected if he receive two-thirds of the votes cast and not less than 20 votes in all, provided that the number of members of the academy be not 150 or over, in which case to be declared elected he must receive four-fifths of the votes cast and not less than 25 votes in all. A vote shall then be taken in similar manner on the nominee standing second on the preference list, and so on until all the nominees on the preference list shall have been acted on, or until 10 nominees shall have been elected.

Not more than 10 members shall be elected at one annual meeting.

Before and during elections a discussion of the merits of nominees will be in order.

The election of members may be suspended at any time by a majority vote of the members present.

SEC. 6. Every member elect shall accept his membership, personally or in writing, before the close of the next stated meeting after the date of his election. Otherwise, on proof that the secretary has formally notified him of his election, his name shall not be entered on the roll of members.

SEC. 7. The election of foreign associates shall be in the following manner:

Foreign associates may be nominated by the council and may be elected at the annual meeting by a two-thirds vote of the members present. Each member shall indicate on a ballot those names for which he votes, and those nominees whose names appear on two-thirds of the votes cast shall be declared elected. A list of those nominated shall be sent to all members of the academy with the notice of the meeting at which the election is to be held.

SEC. 8. A diploma, with the corporate seal of the academy and the signatures of the officers, shall be sent by the appropriate secretary to each member on his acceptance of his membership, and to foreign associates on their election.

SEC. 9. Resignations shall be addressed to the president and acted on by the academy.

SEC. 10. Whenever a member has not paid his dues for four successive years, the treasurer shall report the fact to the council, which may report the case to the academy with the recommendation that

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the person thus in arrears be declared to have forfeited his membership. If this recommendation be approved by two-thirds of the members present, the said person shall no longer be a member of the academy and his name shall be dropped from the roll.

ARTICLE V.—OF SCIENTIFIC COMMUNICATIONS, PUBLICATIONS, AND REPORTS.

SECTION 1. Communications on scientific subjects shall be read at scientific sessions of the academy, and papers by any member may be read by the author or by any other member, notice of the same having been previously given to the secretary.

SEC. 2. Any member of the academy may read a paper from a person who is not a member, and shall not be considered responsible for the facts or opinions expressed by the author, but shall be held responsible for the propriety of the paper.

Persons who are not members may read papers on invitation of the council or of the committee of arrangements.

SEC. 3. The academy may provide for the publication, under the direction of the council, of proceedings, memoirs, and reports.

SEC. 4. Propositions for investigations or reports by the academy shall be submitted to the council for approval, except those requested by the Government of the United States, which shall be acted on by the president, who will in such cases report their results to the Government as soon as obtained and to the academy at its next following stated meeting.

SEC. 5. The advice of the academy shall be at all times at the disposition of the Government upon any matter of science or art within its scope.

SEC. 6. An annual report to be presented to Congress shall be prepared by the president, and before its presentation submitted by him, first to the council and afterwards to the academy, at one of the stated meetings.

SEC. 7. Medals and prizes may be established, and the means of bestowing them accepted by the academy upon the recommendation of the council, by whom all the necessary arrangements for their establishment and award shall be made.

Bequests and trusts having for their object the advancement of science may also be accepted and administered by the academy.

ARTICLE VI.—OF THE PROPERTY OF THE ACADEMY.

SECTION 1. All investments shall be made by the treasurer in the corporate name of the academy with the approval of a finance committee of three members, to be appointed annually by the president, of which the treasurer shall be one. Investments shall be made in bonds of the United States, in State bonds, or bonds or notes secured by first mortgages on real estate, in investments legal for savings

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banks under the laws of Massachusetts or New York, or in other bonds recommended to the treasurer by the fiscal advisers of the academy.

The council shall, at its annual meeting in each year, designate one bank or trust company in Washington, D. C., and one in New York City, to act, when requested by the treasurer, as the fiscal advisers of the academy.

The treasurer shall have the authority, with the approval of the finance committee, to change any investment held by him in the corporate name of the academy.

SEC. 2. No contract shall be binding upon the academy which has not been first approved by the council.

SEC. 3. The assessments required for the support of the academy shall be fixed by the academy on the recommendation of the council.

ARTICLE VII.—OF ADDITIONS AND AMENDMENTS.

Additions and amendments to the constitution shall be made only at a stated meeting of the academy. Notice of a proposition for such a change must be given at a stated meeting, and shall be referred to the council, which may amend the proposition, and shall report thereon to the academy. Its report shall be considered by the academy in committee of the whole for amendment.

The proposition as amended, if adopted in committee of the whole, shall be voted on at the next stated meeting, and if it receives two-thirds of the votes cast it shall be declared adopted.

Absent members may send their votes on pending changes in the constitution to the home secretary in writing, and such votes shall be counted as if the members were present.

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APPENDIX B.

RULES.

I. In the absence of any officer a member shall be chosen to perform his duties temporarily, by a plurality of viva voce votes, upon open nomination.

II. On the first day of each stated session, immediately after calling the roll of members, a recording secretary may be elected, by a plurality of members present, to assist the home secretary in keeping the records of the session.

III. The accounts of the treasurer shall, between January 1 and January 15 of each year, be audited by a committee of three members to be appointed by the president at the autumn meeting of the academy. The auditing committee may employ an expert accountant to examine the books of the treasurer. This committee shall inspect and verify the bonds, securities, and other property in the custody of the treasurer and shall compare the expenditures with the vouchers therefor. The annual report of the treasurer shall be published with that of the president to Congress. The reports of the treasurer and auditing committee shall be presented to the academy at the annual meeting.

IV. A committee of arrangements, consisting of five members, shall be appointed by the president for each stated session of the academy. This committee shall meet not less than two weeks previous to each session. It shall be in session during the meetings to make arrangements for the reception of the members, to arrange the business of each day, and, in general, to attend to all business and scientific arrangements.

It shall be the duty of the committee of arrangements to ascertain the length of time required for reading the several memoirs presented, and, when it appears advisable, to recommend a limit of time to be occupied in their discussion.

V. At the meetings the order of business shall be as follows:

1. Chair taken by the president, or, in his absence, by the vice president.
2. Roll of members called by home secretary.
3. Minutes of the preceding meeting read and approved.
4. Stated business.

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5. Reports of president, secretaries, treasurer, and committees.
6. Business from council.
7. Other business.
8. On the last day of the session the rough minutes of that day's proceedings are to be read for correction.

VI. The rules of order of the academy shall be those of the Senate of the United States, unless suspended by unanimous consent.

VII. Unless otherwise ordered by the academy, the scientific meetings at the April session shall be held in the afternoon, the mornings being reserved for business.

VIII. At each meeting the president shall announce the death of any members who may have died since the preceding meeting. As soon as practicable thereafter he shall designate a member to write—or with the approval of the president to secure from some other source—a biographical notice of each deceased member.

IX. The secretaries will receive memoirs at any time, and report the date of their reception at the next session; but no memoir shall be published unless it has been read or presented by title before the academy.

Before publication all memoirs must be referred to the committee on publication, who may, if they deem best, refer any memoir to a special committee appointed by the president to determine whether the same should be published by the academy.

X. Memoirs shall date, in the records of the academy, from the date of their presentation to the academy, and the order of their presentation shall be so arranged by the secretary that, so far as may be convenient, those upon kindred topics shall follow one another.

XI. Papers from persons not members read before the academy and intended for publication shall be referred at the meeting at which they are read to a committee of members competent to judge whether the paper is worthy of publication. Such committee shall report to the academy as early as practicable, and not later than the next stated session.

XII. The annual report of the academy may be accompanied by a memorial to Congress in regard to such investigations and other subjects as may be deemed advisable, recommending appropriations therefor when necessary.

XIII. The proper secretary shall acknowledge all donations made to the academy, and shall report them at the next stated session.

XIV. The books, apparatus, archives, and other collections of the academy shall be deposited in some safe place in the city of Washington. A list of the articles so deposited shall be kept by the home secretary, who is authorized to employ a clerk to take charge of them.

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XV. A stamp corresponding to the corporate seal of the academy shall be kept by the secretaries, who shall be responsible for the due marking of all books and other objects to which it is applicable.

Labels or other proper marks of similar device shall be placed upon objects not admitting of the stamp.

XVI. The treasurer is authorized to defray, when approved by the president, all the proper expenses of committees appointed to make scientific investigations at the request of departments of the Government, and in each case to look to the department requesting the investigation for reimbursement to the academy.

XVII. Nominations for membership should state the full name, residence, the official position, and the special scientific studies of the candidate. A form of nomination shall be prepared by the home secretary.

XVIII. Ballots for election of members may be sent by sealing them up in a blank envelope, and inclosing this in another, across the back of which is written the name of the sender, and which is addressed to the home secretary; such envelopes will be opened only by the tellers.

XIX. All discussions as to the claims and qualifications of nominees at meetings of the academy will be held strictly confidential, and remarks and criticisms then made may be communicated to no person who was not a member of the academy at the time of the discussion.

XX. Any rule of the academy may be amended, suspended, or repealed on the written motion of any two members, signed by them, and presented at a stated session of the academy, provided the same shall be approved by a majority of the members present.

XXI. The fiscal year of the academy shall end on December 31 of each year.

XXII. The annual reports of the committees on research funds shall, so far as the academy has authority to determine their form, give a current number to each award, stating the name, position, and address of the recipient, the subject of research for which the award is made, and the sum awarded; and in later annual reports the status of the work accomplished under each award previously made shall be announced, until the research is completed, when announcement of its completion and, if published, the title and place of publication shall be stated, and the record of the award shall be reported as closed.

By a resolution adopted January 12, 1864, the president is ex officio a member of all government committees of the academy.

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APPENDIX C.

ORGANIZATION OF THE ACADEMY, 1913-1914.

	Expiration of term.
WELCH, WILLIAM H., *President*	April, 1919
WALCOTT, CHARLES D., *Vice President*	April, 1919
HALE, GEORGE E., *Foreign Secretary*	April, 1916
DAY, ARTHUR L., *Home Secretary*	April, 1919
CROSS, WHITMAN, *Treasurer*	April, 1917

ADDITIONAL MEMBERS OF COUNCIL.

	1911-1914.	
CONKLIN, E. G.		NOYES, A. A.
	1912-1915.	
COUNCILMAN, W. T.		WOODWARD, R. S.
	1913-1916.	
WILSON, E. B.		CHITTENDEN, R. H.

STANDING COMMITTEES OF THE ACADEMY.

1. MATHEMATICS AND ASTRONOMY.

ABBE, CLEVELAND	ELKIN, W. L.	OSGOOD, W. F.
BARNARD, E. E.	FROST, E. B.	PEIRCE, C. S.
BÔCHER, MAXIMÉ	HALE, G. E.	PICKERING, E. C.
BOLZA, OSKAR	HILL, G. W.	STORY, W. E.
CAMPBELL, W. W.	HOLDEN, E. S.[2]	VAN VLECK, E. B.
CHANDLER, S. C.[1]	LEUSCHNER, A. O.	WEBSTER, A. G.
COMSTOCK, G. C. (*Chairman*).	MOORE, E. H.	WOODWARD, R. S.
DICKSON, L. E.	MOULTON, F. R.	

2. PHYSICS AND ENGINEERING.

ABBE, CLEVELAND	HAYFORD, J. F.	ROSA, E. B.
ABBOT, H. L.	MENDENHALL, T. C.	THOMSON, ELIHU
AMES, J. S.	MICHELSON, A. A.	TROWBRIDGE, JOHN
BARUS, C.	MORLEY, E. W.	WEBSTER, A. G.
BELL, A. G.	NICHOLS, E. F.	WOOD, R. W.
BUMSTEAD, H. A.	NICHOLS, E. L.	WOODWARD, R. S. (*Chairman*).
CREW, HENRY	PEIRCE, B. O.[3]	
HALL, E. H.	PICKERING, E. C.	WRIGHT, A. W.
HASTINGS, C. S.	PUPIN, M. I.	

3. CHEMISTRY.

BOLTWOOD, B. B.	JACKSON, C. L.	OSBORNE, T. B.
CHANDLER, C. F.	LEWIS, G. N.	REMSEN, IRA
CHITTENDEN, R. H.	MICHAEL, ARTHUR	RICHARDS, T. W.
CLARKE, F. W.	MORLEY, E. W.	SMITH, E. F.
CRAFTS, J. M.	MORSE, H. N.	STIEGLITZ, J. O.
GOOCH, F. A.	NEF, J. U.	WELLS, H. L.
HILGARD, E. W.	NOYES, A. A. (*Chairman*).	WHEELER, H. L.
HILLEBRAND, W. F.	NOYES, W. A.	

[1] Died Jan. 10, 1914. [2] Died Mar. 16, 1914. [3] Died Jan. 14, 1914.

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4. GEOLOGY AND PALEONTOLOGY.

Becker, G. F.
Branner, J. C.
Chamberlin, T. C.
Clark, W. B.
Clarke, J. M.
Cross, Whitman
Dall, W. H.
Dana, E. S.
Davis, W. M.
Day, A. L.
Gilbert, G. K.
Hague, Arnold (*Chairman*).
Iddings, J. P.
Kemp, J. F.
Lindgren, Waldemar
Osborn, H. F.
Pirsson, L. V.
Pumpelly, Raphael
Reid, H. F.
Schuchert, Charles
Scott, W. B.
Van Hise, C. R.
Walcott, C. D.
White, David

5. BOTANY.

Campbell, D. H.
Coulter, J. M.
Farlow, W. G.
Goodale, G. L.
Harper, R. A.
Sargent, C. S.
Smith, E. F.
Thaxter, Roland
Trelease, William (*Chairman*).

6. ZOOLOGY AND ANIMAL MORPHOLOGY.

Allen, J. A.
Conklin, E. G. (*Chairman*).
Dall, W. H.
Davenport, C. B.
Gill, T. N.
Harrison, R. G.
Mall, F. P.
Mark, E. L.
Merriam, C. H.
Minot, C. S.
Morgan, T. H.
Morse, E. S.
Osborn, H. F.
Parker, G. H.
Verrill, A. E.
Walcott, C. D.
Wheeler, W. M.
Wilson, E. B.

7. PHYSIOLOGY AND PATHOLOGY.

Abel, J. J.
Chittenden, R. H. (*Chairman*).
Councilman, W. T.
Flexner, Simon
Howell, W. H.
Loeb, Jacques
Mall, F. P.
Meltzer, S. J.
Mendel, L. B.
Minot, C. S.
Mitchell, S. W.[1]
Prudden, T. M.
Smith, Theobald
Welch, W. H.
Wood, H. C.

8. ANTHROPOLOGY AND PSYCHOLOGY.

Boas, Franz
Cattell, J. McK.
Dewey, John
Holmes, W. H. (*Chairman*).
Merriam, C. H.
Morse, E. S.
Peirce, C. S.
Putnam, F. W.
Royce, Josiah

ON WEIGHTS, MEASURES, AND COINAGE.

Mendenhall, T. C., *Chairman*.
Michelson, A. A.
Morley, E. W.
Peirce, C. S.
Webster, A. G.
Woodward, R. S.

ON PUBLICATION.

The President. The Home Secretary. Walcott, C. D.

ON SOLAR RESEARCH.

Hale, G. E., *Chairman*. Campbell, W. W. Nichols, E. L.
Michelson, A. A. Pickering, E. C.

FINANCE COMMITTEE.

Cross, Whitman Gill, T. N. Walcott, C. D.

[1] Died Jan. 4, 1914.

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TRUST FUNDS.

THE BACHE FUND.

[$56,000.]

For researches in physical and natural science.

MINOT, C. S., *Chairman.* FROST, E. B. REMSEN, IRA

THE WATSON FUND.

[$25,000.]

For the promotion of astronomical research.

PICKERING, E. C., *Chairman.* ELKIN, W. L. FROST, E. B.

THE HENRY DRAPER FUND.

[$10,000.]

Award of medal for important discoveries in astronomy.

HALE, G. E., *Chairman.* CAMPBELL, W. W. TROWBRIDGE, JOHN
MICHELSON, A. A. WRIGHT, A. W.

THE J. LAWRENCE SMITH FUND.

[$10,000.]

For the investigation of meteoric bodies.

MORLEY, E. W., *Chairman.* DANA, E. S. HAGUE, ARNOLD
PUMPELLY, RAPHAEL REMSEN, IRA

THE BENJAMIN APTHORP GOULD FUND.

[$20,000.]

For researches in astronomy.

MOULTON, F. R., *Chairman.* BARNARD, E. E.[1] HILL, G. W.

THE BARNARD MEDAL.[2]

For meritorious service to science.

WOODWARD, R. S., *Chairman.* CAMPBELL, W. W. NICHOLS, E. F.
NOYES, A. A. RICHARDS, T. W.

THE WOLCOTT GIBBS FUND.

[$5,500.]

For chemical research.

JACKSON, C. L., *Chairman.* REMSEN, IRA SMITH, E. F.

THE COMSTOCK FUND.

[$11,303.52.]

For researches in electricity, magnetism, and radiant energy.

NICHOLS, E. L., *Chairman.* CREW, HENRY NOYES, A. A.
THOMSON, ELIHU WEBSTER, A. G.

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[1] Appointed in place of S. C. Chandler, deceased.

[2] Every five years the committee recommends the person whom they consider most deserving of the medal, and upon the approval of the Academy the name of the nominee is forwarded to the trustees of Columbia College, who administer the Barnard Medal Fund.

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THE MARSH FUND.

[$9,377.65.]

For promoting original research in the natural sciences.

THE AGASSIZ FUND.

[$50,000.]

For the general uses of the Academy.

THE MURRAY FUND.

[$6,000.]

For original contributions to the science of oceanography.

HAGUE, ARNOLD, *Chairman.* DALL, W. H. GILL, T. N.

THE MARCELLUS HARTLEY FUND.

[$500.]

THOMSON, ELIHU, *Chairman.* OSBORN, H. F. WEBSTER, A. G.
BECKER, G. F. PUPIN, M. I. WELCH, W. H.
HILLEBRAND, W. F.

JOSEPH HENRY FUND.

To assist meritorious investigators, especially in the direction of original research.

The sum of $40,000 was contributed by Fairman Rogers, Joseph Patterson, George W. Childs, and others as an expression of their respect and esteem for Prof. Joseph Henry. This amount was deposited with the Pennsylvania Co. for the Insurance of Lives and Granting Annuities in Trust, with authorization to collect the income thereon and to pay over the same to Prof. Joseph Henry during his natural life, and after his death to his wife and daughters, and after the death of the last survivor to "deliver the said fund and the securities in which it shall then be invested to the National Academy of Sciences, to be thenceforward forever held in trust under the name and title of the 'Joseph Henry Fund.' "

MEMBERS OF THE NATIONAL ACADEMY OF SCIENCES, DECEMBER 31, 1913.

		Date of election.
ABBE, CLEVELAND	*U. S. Weather Bureau, Washington, D. C.*	1879
ABBOT, HENRY L., U. S. A	*23 Berkeley St., Cambridge, Mass.*	1872
ABEL, JOHN JACOB	*Johns Hopkins University, Baltimore, Md.*	1912
ALLEN, J. ASAPH	*American Museum of Natural History, New York City.*	1876
AMES, JOSEPH S	*Johns Hopkins University, Baltimore, Md.*	1909
BARNARD, E. E	*Yerkes Observatory, Williams Bay, Wis.*	1911
BARUS, CARL	*Brown University, Providence, R. I.*	1892
BECKER, GEORGE F	*U. S. Geological Survey, Washington, D. C.*	1901
BELL, A. GRAHAM	*1331 Connecticut Ave., Washington, D. C.*	1883
BOAS, FRANZ	*123 W. Eighty-second St., New York City.*	1900
BÔCHER, MAXIMÉ	*Harvard University, Cambridge, Mass.*	1909
BOLTWOOD, B. B	*Yale University, New Haven, Conn.*	1911
BOLZA, OSKAR	*Reichsgrafenstr. 10, Freiburg, Germany.*	1909
BRANNER, JOHN C	*Stanford University, California.*	1905
BUMSTEAD, HENRY ADAMS	*Yale University, New Haven, Conn.*	1913
CAMPBELL, D. H	*Stanford University, California.*	1910
CAMPBELL, WILLIAM W	*Lick Observatory, Mount Hamilton, California.*	1902
CATTELL, JAMES MCK	*Garrison, N. Y.*	1901
CHAMBERLIN, THOMAS C	*University of Chicago, Chicago, Ill.*	1903
CHANDLER, CHARLES F	*Columbia University, New York City.*	1874
CHANDLER, SETH C.[1]	*Box 216, Wellesley Hills, Mass.*	1888
CHITTENDEN, RUSSELL H	*Sheffield Scientific School, New Haven, Conn.*	1890

[1] Died Jan. 10, 1914.

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		Date of election.
CLARK, W. B	*Johns Hopkins University, Baltimore, Md.*	1908
CLARKE, F. W	*U. S. Geological Survey, Washington, D. C.*	1909
CLARKE, J. M	*State Hall, Albany, N. Y.*	1909
COMSTOCK, GEORGE C	*Washburn Observatory, Madison, Wis.*	1899
CONKLIN, E. G	*Princeton, N. J.*	1908
COULTER, J. M	*University of Chicago, Chicago, Ill.*	1909
COUNCILMAN, WILLIAM T	*Harvard Medical School, Boston, Mass.*	1904
CRAFTS, JAMES M	*59 Marlborough St., Boston, Mass.*	1872
CREW, HENRY	*Northwestern University, Evanston, Ill.*	1909
CROSS, WHITMAN	*U. S. Geological Survey, Washington, D. C.*	1908
DALL, WILLIAM H	*Smithsonian Institution, Washington, D. C.*	1897
DANA, EDWARD S	*Yale University, New Haven, Conn.*	1884
DAVENPORT, CHARLES B	*Cold Spring Harbor, N. Y.*	1912
DAVIS, WILLIAM MORRIS	*17 Francis Ave., Cambridge, Mass.*	1904
DAY, ARTHUR L	*Geophysical Laboratory, Washington, D. C.*	1911
DEWEY, JOHN	*Columbia University, New York City.*	1910
DICKSON, LEONARD E	*University of Chicago, Chicago, Ill.*	1913
ELKIN, WILLIAM L	*Yale University Observatory, New Haven, Conn.*	1895
FARLOW, W. G	*Harvard University, Cambridge, Mass.*	1879
FLEXNER, SIMON	*Rockefeller Institute, New York City.*	1908
FROST, EDWIN B	*Yerkes Observatory, Williams Bay, Wis.*	1908
GILBERT, GROVE K	*U. S. Geological Survey, Washington, D. C.*	1883
GILL, THEODORE N	*Smithsonian Institution, Washington, D. C.*	1873
GOOCH, FRANK A	*Yale University, New Haven, Conn.*	1897
GOODALE, GEORGE L	*Harvard University, Cambridge, Mass.*	1890
HAGUE, ARNOLD	*U. S. Geological Survey, Washington, D. C.*	1885
HALE, GEORGE E	*Solar Observatory Office, Pasadena, Cal.*	1902
HALL, EDWIN H	*Harvard University, Cambridge, Mass.*	1911
HARPER, R. A	*Columbia University, New York City.*	1911
HARRISON, ROSS G	*Yale University, New Haven, Conn.*	1913
HASTINGS, CHARLES S	*Yale University, New Haven, Conn.*	1889
HAYFORD, JOHN F	*Northwestern University, Evanston, Ill.*	1911
HILGARD, EUGENE W	*University of California, Berkeley, Cal.*	1872
HILL, GEORGE W	*West Nyack, N. Y.*	1874
HILLEBRAND, WILLIAM F	*Bureau of Standards, Washington, D. C.*	1908
HOLDEN, EDWARD S.[1]	*U. S. Military Academy, West Point, N. Y.*	1885
HOLMES, WILLIAM H	*U. S. National Museum, Washington, D. C.*	1905
HOWELL, WILLIAM H	*Johns Hopkins University, Baltimore, Md.*	1905
IDDINGS, JOSEPH P	*U. S. Geological Survey, Washington, D. C.*	1907
JACKSON, CHARLES L	*6 Boylston Hall, Cambridge, Mass.*	1883
KEMP, JAMES F	*Columbia University, New York City.*	1911
LEUSCHNER, ARMIN O	*University of California, Berkeley, Cal.*	1913
LEWIS, GILBERT N	*University of California, Berkeley, Cal.*	1913
LINDGREN, WALDEMAR	*Massachusetts Institute of Technology, Boston, Mass.*	1909
LOEB, JACQUES	*Rockefeller Institute, New York City.*	1910
MALL, FRANKLIN P	*Johns Hopkins University, Baltimore, Md.*	1907
MARK, EDWARD L	*109 Irving St., Cambridge, Mass.*	1903
MELTZER, SAMUEL JAMES	*Rockefeller Institute, New York City.*	1912
MENDEL, LAFAYETTE B	*18 Trumbull St., New Haven, Conn.*	1913
MENDENHALL, THOMAS C	*329 North Chestnut St., Ravenna, Ohio.*	1887
MERRIAM, C. HART	*1919 Ave. of the Presidents, Washington, D. C.*	1902

[1] Died Mar. 16, 1914.

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		Date of election.
MICHAEL, ARTHUR	*219 Parker St., Newton Center, Mass.*	1889
MICHELSON, ALBERT A	*University of Chicago, Chicago, Ill.*	1888
MINOT, CHARLES S	*Harvard Medical School, Boston, Mass.*	1897
MITCHELL, S. WEIR[1]	*1524 Walnut St., Philadelphia, Pa.*	1865
MOORE, ELIAKIM H	*University of Chicago, Chicago, Ill.*	1901
MORGAN, T. H	*Columbia University, New York City.*	1909
MORLEY, EDWARD W	*West Hartford, Conn.*	1897
MORSE, EDWARD S	*Salem, Mass.*	1876
MORSE, HARMON N	*Johns Hopkins University, Baltimore, Md.*	1907
MOULTON, F. R	*University of Chicago, Chicago, Ill.*	1910
NEF, JOHN ULRIC	*University of Chicago, Chicago, Ill.*	1904
NICHOLS, EDWARD L	*Cornell University, Ithaca, N. Y.*	1901
NICHOLS, ERNEST F	*Dartmouth College, Hanover, N. H.*	1908
NOYES, ARTHUR A	*Massachusetts Institute of Technology, Boston, Mass.*	1905
NOYES, WILLIAM A	*University of Illinois, Urbana, Ill.*	1910
OSBORN, H. F	*American Museum of Natural History, New York City.*	1900
OSBORNE, T. B	*Agricultural Experiment Station, New Haven, Conn.*	1910
OSGOOD, WILLIAM FOGG	*Harvard University, Cambridge, Mass.*	1904
PARKER, GEORGE H	*16 Berkeley St., Cambridge, Mass.*	1913
PEIRCE, BENJAMIN O.[2]	*Harvard University, Cambridge, Mass.*	1906
PEIRCE, CHARLES S	*Milford, Pa.*	1876
PICKERING, EDWARD C	*Harvard College Observatory, Cambridge, Mass.*	1873
PIRSSON, LOUIS V	*41 Trumbull St., New Haven, Conn.*	1913
PRUDDEN, T. MITCHELL	*Columbia University, New York City.*	1901
PUMPELLY, RAPHAEL	*Gibbs Ave., Newport, R. I.*	1872
PUPIN, MICHAEL I	*Columbia University, New York City.*	1905
PUTNAM, FREDERICK W	*Peabody Museum, Cambridge, Mass.*	1885
REID, H. FIELDING	*Johns Hopkins University, Baltimore, Md.*	1912
REMSEN, IRA	*Johns Hopkins University, Baltimore, Md.*	1882
RICHARDS, THEODORE W.	*Wolcott Gibbs Memorial Laboratory, Cambridge, Mass.*	1899
ROSA, EDWARD B	*Bureau of Standards, Washington, D. C.*	1913
ROYCE, JOSIAH	*Harvard University, Cambridge, Mass.*	1906
SARGENT, CHARLES S	*Arnold Arboretum, Jamaica Plain, Mass.*	1895
SCHUCHERT, CHARLES	*Yale University, New Haven, Conn.*	1910
SCOTT, WILLIAM B	*Princeton University, Princeton, N. J.*	1906
SMITH, EDGAR F	*University of Pennsylvania, Philadelphia, Pa.*	1899
SMITH, ERWIN F	*Bureau of Plant Industry, Washington, D. C.*	1913
SMITH, THEOBALD	*Harvard Medical School, Boston, Mass.*	1908
STIEGLITZ, J. O	*University of Chicago, Chicago, Ill.*	1911
STORY, WILLIAM E	*Clark University, Worcester, Mass.*	1908
THAXTER, ROLAND	*Harvard University, Cambridge, Mass.*	1912
THOMSON, ELIHU	*Swampscott, Mass.*	1907
TRELEASE, WILLIAM	*University of Illinois, Urbana, Ill.*	1902
TROWBRIDGE, JOHN	*Harvard University, Cambridge, Mass.*	1878
VAN HISE, C. R	*University of Wisconsin, Madison, Wis.*	1902
VAN VLECK, E. B	*University of Wisconsin, Madison, Wis.*	1911
VERRILL, A. E	*Yale University, New Haven, Conn.*	1872
WALCOTT, CHARLES D	*Smithsonian Institution, Washington, D. C.*	1896
WEBSTER, ARTHUR G	*Clark University, Worcester, Mass.*	1903
WELCH, WILLIAM H	*807 St. Paul St., Baltimore, Md.*	1895
WELLS, HORACE L	*Yale University, New Haven, Conn.*	1903

[1] Died Jan. 4, 1914.

[2] Died Jan. 14, 1914.

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		Date of election.
WHEELER, HENRY L.	*Sheffield Scientific School, New Haven, Conn.*	1909
WHEELER, WILLIAM M.	*Harvard University, Cambridge, Mass.*	1912
WHITE, DAVID	*U. S. Geological Survey, Washington, D. C.*	1912
WILSON, EDMUND B.	*Columbia University, New York City.*	1899
WOOD, HORATIO C.	*4107 Chester Ave., Philadelphia, Pa.*	1879
WOOD, ROBERT W.	*Johns Hopkins University, Baltimore, Md.*	1912
WOODWARD, ROBERT S.	*Carnegie Institution, Washington, D. C.*	1896
WRIGHT, ARTHUR W.	*Yale University, New Haven, Conn.*	1881

HONORARY MEMBER.

SMITH, SIDNEY I.	*Yale University, New Haven, Conn.*	1884

FOREIGN ASSOCIATES.

ARRHENIUS, S. A.	*Nobelinstitut, Stockholm.*	1908
AUWERS, G. F. J. ARTHUR	*Bellevue Str. 55, Grosslichterfelde W., Berlin.*	1883
BACKLUND, OSKAR	*Astron. Sternwarte, Pulkowa.*	1903
BAEYER, ADOLPH RITTER VON	*Universität, Munich.*	1898
BARROIS, CHARLES	*Université, Lille.*	1908
BOVERI, THEODOR	*Würzburg.*	1913
BRØGGER, W. C.	*Universitet, Christiania.*	1903
CROOKES, SIR WILLIAM	*London.*	1913
DARBOUX, GASTON	*Academy of Sciences, Paris.*	1913
DESLANDRES, HENRI	*Astrophysical Observatory, Meudon.*	1913
DEWAR, SIR JAMES	*University, Cambridge.*	1907
EHRLICH, PAUL	*Königl. Inst. für Exper. Therapie, Frankfurt a. Main.*	1904
FISCHER, EMIL	*Chemisches Inst. der Universität, Berlin.*	1904
FORSYTH, A. R.	*Trinity College, Cambridge.*	1907
GEIKIE, SIR ARCHIBALD	*Haslemere, Surrey.*	1901
GILL, SIR DAVID[1]	*34 De Vere Gardens, Kensington, London, W.*	1898
GROTH, PAUL VON	*Universität, Munich.*	1905
HEIM, ALBERT	*Zürich.*	1913
HILBERT, DAVID	*Universität, Göttingen.*	1907
KAPTEYN, JOHN C.	*Rijks Universiteit, Groningen.*	1907
KLEIN, FELIX	*Universität, Göttingen.*	1898
KÖSSEL, ALBRECHT	*Heidelberg.*	1913
KRONECKER, HUGO	*Kantonale Universität, Berne.*	1901
KUSTNER, KARL FRIEDRICH	*Bonn.*	1913
LANKESTER, E. RAY	*South Kensington, London.*	1903
LARMOR, SIR JOSEPH	*St. Johns College, Cambridge.*	1908
LORENTZ, HENDRIK ANTON	*Rijks Universiteit, Leiden.*	1906
MURRAY, SIR JOHN[2]	*Edinburgh.*	1912
OSTWALD, WILHELM	*Grossbothen, bei Leipzig.*	1906
PAVLOV, IVAN PETROVITCH	*Kais. Inst. für Exper. Med., St. Petersburg.*	1908
PENCK, ALBRECHT	*Universität, Berlin.*	1909
PFEFFER, WILHELM	*Bot. Inst. der Universität, Leipzig.*	1903
PICARD, CHARLES ÉMILE	*Université, Paris.*	1903
RAMSAY, SIR WILLIAM	*University College, London.*	1904
RAYLEIGH, LORD	*University, Cambridge.*	1898
RETZIUS, GUSTAV	*Högskolan, Stockholm.*	1909
ROSENBUSCH, H.[3]	*Universität, Heidelberg.*	1904
RUTHERFORD, ERNEST	*University, Manchester.*	1911

[1] Died Jan. 24, 1914. [2] Died Mar. 16, 1914. [3] Died Jan. 14, 1914.

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		Date of election.
SCHUSTER, ARTHUR	*Secretary of the Royal Society, London.*	1913
SEELIGER, HUGO RITTER VON	*Universität, Munich.*	1908
SUESS, EDOUARD	*Universität, Wien.*	1898
THOMSON, SIR JOSEPH	*University, Cambridge.*	1903
VOLTERRA, VITO	*Università, Rome.*	1911
VRIES, HUGO DE	*Universiteit, Amsterdam.*	1904
WAALS, JOHANNES D. VAN DER	*Amsterdam.*	1913
WALDEYER, WILHELM	*Universität, Berlin.*	1909
WEISMANN, AUGUST	*Freiburg i. Br.*	1913
WOLF, MAX F. J. C.	*Heidelberg.*	1913
WUNDT, WILHELM	*Universität, Leipzig.*	1909

DECEASED MEMBERS.

	Date of election.	Date of death.
AGASSIZ, ALEXANDER	1866	Mar. 27, 1910
AGASSIZ, LOUIS	(1)	Dec. 14, 1873
ALEXANDER, J. H.	(1)	Mar. 2, 1867
ALEXANDER, STEPHEN	(1)	June 25, 1883
BACHE, ALEXANDER DALLAS	(1)	Feb. 14, 1867
BAIRD, SPENCER F.	1864	Aug. 19, 1887
BARKER, GEORGE F.	1876[2]	May 24, 1910
BARNARD, F. A. P.	(1) (2)	Apr. 27, 1889
BARNARD, J. G.	(1)	May 14, 1882
BARTLETT, W. H. C.	(1)	Feb. 11, 1898
BEECHER, CHARLES EMERSON	1899	Feb. 14, 1904
BILLINGS, JOHN S.	1883[2]	Mar. 11, 1913
BOSS, LEWIS	1889[2]	Oct. 5, 1912
BOWDITCH, HENRY P.	1887[2]	Mar. 13, 1911
BREWER, WILLIAM H.	1880[2]	Nov. 2, 1910
BROOKS, WILLIAM KEITH	1884	Nov. 12, 1908
BROWN-SEQUARD, CHARLES E.	1868	Apr. 2, 1894
BRUSH, GEORGE JARVIS	1868[2]	Feb. 6, 1912
CASEY, THOMAS L.	1890	Mar. 25, 1896
CASWELL, ALEXIS	(1)	Jan. 8, 1887
CHAUVENET, WILLIAM	(1)	Dec. 13, 1870
CLARKE, HENRY JAMES	1872	July 1, 1873
COFFIN, JAMES	1869	Jan. 6, 1873
COFFIN, J. H. C.	(1)	Jan. 8, 1890
COMSTOCK, CYRUS B.	1884	May 29, 1910
COOK, GEORGE H.	1887	Sept. 22, 1889
COOKE, JOSIAH P.	1872	Sept. 3, 1894
COPE, EDWARD D.	1872[2]	Apr. 12, 1897
COUES, ELLIOTT	1877	Dec. 25, 1899
DALTON, J. C.	1864	Feb. 2, 1889
DANA, JAMES D.	(1) (2)	Apr. 14, 1895
DAVIDSON, GEORGE	1874[2]	Dec. 2, 1911
DAVIS, CHARLES H.	(1)	Feb. 14, 1877
DRAPER, HENRY	1877	Nov. 20, 1882
DRAPER, JOHN W.	1877	Jan. 4, 1882
DUTTON, C. E.	1884[2]	Jan. 4, 1912
EADS, JAMES B.	1872	Mar. 8, 1887
EMMONS, SAMUEL, F.	1892	Mar. 28, 1911

[1] Charter members, Mar. 3, 1863.

[2] Biographical notices have not been presented.

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Deceased members—Continued.

	Date of election.	Date of death.
ENGLEMANN, GEORGE	(1)	Feb. 4, 1884
FERREL, WILLIAM	1868	Sept. 18, 1891
FRASER, JOHN FRIES	(1)	Oct. 12, 1872
GABB, WILLIAM M	1876	May 30, 1878
GENTH, F. A	1872	Feb. 2, 1893
GIBBS, JOSIAH WILLARD	1879	Apr. 28, 1903
GIBBS, WOLCOTT	(1)	Dec. 9, 1908
GILLIS, JAMES MELVILLE	(1)	Feb. 9, 1865
GOODE, G. BROWN	1888	Sept. 6, 1896
GOULD, AUGUSTUS A	(1)	Sept. 15, 1866
GOULD, BENJAMIN A	(1) (2)	Nov. 27, 1896
GRAY, ASA	(1)	Jan. 30, 1888
GUYOT, ARNOLD	(1)	Feb. 8, 1884
HADLEY, JAMES	1864	Aug. 1, 1872
HALDEMAN, S. S	1876	Sept. 20, 1880
HALL, ASAPH	1875	Nov. 22, 1907
HALL, JAMES	(1) (2)	Aug. 8, 1898
HAYDEN, F. V	1873	Dec. 22, 1887
HENRY, JOSEPH	(1)	May 13, 1878
HILGARD, JULIUS E	(1)	May 8, 1891
HILL, HENRY B	1883	Apr. 6, 1908
HITCHCOCK, EDWARD	(1)	Feb. 27, 1864
HOLBROOK, J. E	1868	Sept. 8, 1871
HUBBARD, J. S	(1)	Aug. 16, 1882
HUMPHREYS, A. A	(1)	Nov. 28, 1883
HUNT, T. STERRY	1873	Feb. 12, 1892
HYATT, ALPHEUS	1875	Jan. 16, 1902
JOHNSON, S. W	1866	July 21, 1909
KEELER, J. E	1900	Aug. 12, 1900
KING, CLARENCE	1876	Dec. 24, 1901
KIRKLAND, JARED P	1865	Dec. 10, 1877
LANE, J. HOMER	1872	May 3, 1880
LANGLEY, SAMUEL P	1876	Feb. 27, 1906
LE CONTE, JOHN	1878	Apr. 29, 1891
LE CONTE, JOHN L	(1)	Nov. 15, 1883
LE CONTE, JOSEPH	1875	July 6, 1901
LEA, MATTHEW CAREY	1892	Mar. 15, 1897
LEIDY, JOSEPH	(1)	Apr. 30, 1891
LESLEY, J. PETER	(1) (2)	June 3, 1903
LESQUEREUX, LEO	1864	Oct. 25, 1889
LONGSTRETH, MIERS F	(1) (2)	Dec. 27, 1891
LOOMIS, ELIAS	1873	Aug. 16, 1889
LOVERING, JOSEPH	1873	Jan. 18, 1892
LYMAN, THEODORE	1872	Sept. 10, 1897
MAHAN, D. H	(1)	Sept. 16, 1871
MARSH, G. P	1866	July 23, 1882
MARSH, O. C	1874	Mar. 18, 1899
MAYER, ALFRED M	1872	July 13, 1897
MAYO-SMITH, RICHMOND	1890	Nov. 11, 1901
MEEK, F. B	1869	Dec. 21, 1877
MEIGS, M. C	1865	Jan. 2, 1892
MITCHELL, HENRY	1885	Dec. 1, 1902
MORGAN, LEWIS H	1875	Dec. 14, 1881
MORTON, HENRY	1874	May 9, 1902

[1] Charter members, Mar. 3, 1863. [2] Biographical notices have not been presented.

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Deceased members—Continued.

	Date of election.	Date of death.
NEWBERRY, J. S.	(1)	Dec. 7, 1892
NEWCOMB, SIMON	1869 [2]	July 11, 1909
NEWTON, H. A.	(1)	Aug. 1, 1896
NEWTON, JOHN	1876	May 1, 1895
NORTON, WILLIAM A.	1873	Sept. 21, 1883
OLIVER, JAMES E.	1872	Mar. 27, 1895
PACKARD, A. S.	1872 [2]	Feb. 14, 1905
PENFIELD, SAMUEL L.	1900	Aug. 13, 1906
PETERS, C. H. F.	1876 [2]	July 18, 1890
POURTALES, L. F.	1873	July 19, 1880
POWELL, JOHN W.	1880 [2]	Sept. 23, 1902
RODGERS, JOHN	(1)	May 5, 1882
ROGERS, FAIRMAN	(1)	Aug. 23, 1900
ROGERS, ROBERT E.	(1)	Sept. 7, 1884
ROGERS, WILLIAM A.	1885	Mar. 1, 1896
ROGERS, WILLIAM B.	(1)	May 30, 1882
ROOD, OGDEN N.	1885	Nov. 12, 1902
ROWLAND, HENRY A.	1881	Apr. 16, 1901
RUTHERFURD, LEWIS M.	(1)	May 30, 1892
SAXTON, JOSEPH	(1)	Oct. 26, 1873
SCHOTT, CHARLES A.	1872 [2]	July 31, 1901
SCUDDER, SAMUEL H.	1877 [2]	May 17, 1911
SELLERS, WILLIAM	1873 [2]	Jan. 24, 1905
SILLIMAN, BENJ. Sr.	(1)	Nov. 24, 1864
SILLIMAN, BENJ. Jr.	(1)	Jan. 14, 1885
SMITH, J. LAWRENCE	1872	Oct. 12, 1883
STIMPSON, WILLIAM	1868 [2]	May 26, 1873
STRONG, THEODORE	(1)	Feb. 1, 1869
SULLIVANT, W. S.	1873	Apr. 30, 1882
TORREY, JOHN	(1)	Mar. 10, 1873
TOTTEN, J. G.	(1)	Apr. 22, 1864
TROWBRIDGE, WILLIAM P.	1872	Aug. 12, 1892
TRUMBULL, JAMES H.	1872	Aug. 5, 1897
TUCKERMAN, EDWARD	1868	Mar. 15, 1886
WALKER, FRANCIS A.	1878	Jan. 5, 1897
WARREN, G. K.	1876	Aug. 8, 1882
WATSON, JAMES C.	1868	Nov. 23, 1880
WATSON, SERENO	1889	Mar. 9, 1892
WHITE, CHARLES A.	1889	June 29, 1910
WHITMAN, C. O.	1895	Dec. 6, 1910
WINLOCK, JOSEPH	(1)	June 11, 1875
WOODWARD, J. J.	1873	Aug. 17, 1884
WORTHEN, A. H.	1872	May 6, 1888
WYMAN, JEFFRIES	(1)	Sept. 4, 1874
YOUNG, CHARLES A.	1872	Jan. 3, 1908

[1] Charter members, Mar. 3, 1863.

[2] Biographical notices have not been presented.

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DECEASED FOREIGN ASSOCIATES.

ADAMS, J. C.
AIRY, SIR GEORGE B.
ARGELANDER, F. W. A.
BAER, KARL ERNEST VON
BARRANDE, JOACHIM
BEAUMONT, L. ÉLIE DE
BECQUEREL, HENRI
BERTHELOT, M. P. E.
BERTRAND, J. L. F.
BOLTZMANN, LUDWIG
BORNET, EDOUARD
BOUSSINGAULT, J. B. J. D.
BRAUN, ALEXANDER
BREWSTER, SIR DAVID
BUNSEN, ROBERT W.
BURMEISTER, C. H. C.
CANDOLLE, ALPHONSE DE
CAYLEY, ARTHUR
CHASLES, MICHEL
CHEVREUL, M. E.
CLAUSIUS, RUDOLPH
CORNU, ALFRED
DARWIN, SIR GEORGE HOWARD
DOVE, H. W.
DUMAS, J. B.
FARRADAY, MICHAEL
GEGENBAUR, KARL
GYLDÉN, HUGO
HAMILTON, SIR WILLIAM ROWAN
HELMHOLTZ, BARON H. VON
HOFF, J. H. VAN'T
HOFMANN, A. W.
HOOKER, SIR JOSEPH D.
HUGGINS, SIR WILLIAM
HUXLEY, T. H.
IBAÑEZ, CARLOS
JANSSEN, J.
JOULE, JAMES P.
KEKULÉ, AUGUST
KELVIN, LORD
KIRCHOFF, G. R.
KOCH, ROBERT
KOHLRAUSCH, FRIEDRICH
KÖLLIKER, ALBERT VON
LACAZE-DUTHIERS, HENRI DE
LEUCKART, RUDOLPH
LIE, SOPHUS
LIEBIG, JUSTUS VON
LISTER, LORD
LOEWY, MAURICE
LUDWIG, K. F. W.
MAREY, E. J.
MENDELÉEFF, D. I.
MILNE-EDWARDS, HENRI
MOISSAN, HENRI
MURCHISON, SIR RODERICK I.
OPPOLZER, THEODORE VON
OWEN, SIR RICHARD
PASTEUR, LOUIS
PETERS, C. A. F.
PLANA, G. A. A.
POINCARÉ, JULES HENRI
RAMMELSBERG, C. F.
REGNAULT, VICTOR
REYMOND, EMIL DU BOIS
RICHTHOFEN, F. VON
SACHS, JULIUS VON
SCHIAPARELLI, GIOVANNI
STAS, JEAN SERVAIS
STOKES, SIR GEORGE G.
STRASBURGER, EDOUARD
STRUVE, OTTO VON
SYLVESTER, J. J.
TISSERAND, F. F.
VIRCHOW, RUDOLPH VON
VOGEL, H. C.
WEIERSTRASS, KARL
WÖHLER, FRIEDRICH
WÜRTZ, ADOLPH
ZIRKEL, FERDINAND
ZITTEL, K. A. R. VON

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APPENDIX D.

THE SEMICENTENNIAL ANNIVERSARY OF THE NATIONAL ACADEMY OF SCIENCES.

APRIL 22, 1913.

ADDRESS OF WELCOME BY THE PRESIDENT OF THE ACADEMY, IRA REMSEN.

As presiding officer of the academy for the time being, it is my duty to express our gratification at the coming together of our guests and to extend to you a welcome.

We have come together especially to take note of the fact that 50 years ago a number of prominent workers in the field of science founded the National Academy of Sciences, receiving a charter from the United States Government. It would be interesting and instructive to call the roll of the founders and learn who they were, but it will suffice to refer to some of the most eminent or most conspicuous among these, or perhaps it would be better to say some of those whose names are most familiar to the present generation.

High up on this honor list are Louis Agassiz, James D. Dana, Wolcott Gibbs, B. A. Gould, Asa Gray, A. Guyot, Joseph Henry, J. Leidy, J. P. Lesley, Benjamin Peirce, R. E. Rogers, W. B. Rogers, L. M. Rutherfurd, Benjamin Silliman, Jeffries Wyman, and J. D. Whitney.

Fifty names are included in the act of incorporation. Among these are several members of the United States Army and Navy, as for example, J. G. Barnard, J. A. Dahlgren, Charles H. Davis, John Rodgers, J. G. Totten, and others holding positions in the United States Military Academy and the United States Naval Observatory and the Naval Academy.

A careful scrutiny of the list of incorporators will show that they can be classified under three heads. The majority were engaged in scientific researches and had reached results of value. They were the leaders among the scientific investigators of that day. Then there were those who had gained distinction by their services as engineers, either in the Army or Navy; and a third class was composed of heads of the national institutions, such as the United States Naval Observatory, Naval Academy, Military Academy, and Coast Survey.

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Section 2 of the act of incorporation provides that the academy, "* * * shall consist of not more than 50 ordinary members, and . * * * shall have power to make its own organization, including its constitution, by-laws, and rules and regulations."

Nothing is said in regard to the qualifications for membership. This is equally true of the constitution and rules, except that Article I, section 1, of the constitution, requires that "members must be citizens of the United States." It should, however, be noted that Article IV, section 4, of the constitution, contains this clause: "* * * Each nomination shall be accompanied by a list of the principal contributions of the nominee to science." The reference is to nominations for membership, and the inference is clear that the nominee was assumed to have original works to his credit.

Whatever may have been the views of the incorporators, it has gradually come to be held that membership should stand for successful activity in the field of scientific research, the word "scientific" as here used meaning that which pertains to the natural sciences and physical sciences, if there is a difference. But our predecessors did not intend to bind themselves to this meaning, as is clearly shown by the election of James Hadley in 1864, G. P. Marsh in 1865, and later of Francis A. Walker and Richmond Mayo-Smith.

As regards engineers who were prominently recognized in the early days of the academy, the change of attitude that is worthy of notice is, briefly, this: While one who had accomplished some engineering feat was formerly regarded as worthy of membership by virtue of that fact, now the view appears to prevail—there is no constitutional provision—that only such engineers as have advanced their subject by original contributions should be recognized.

Finally, it is no longer held that the heads of scientific bureaus or departments of the United States Government should necessarily be made members of the academy, no matter whether they have been actively engaged in scientific research or not. It is evident, therefore, that the field of choice has gradually become narrower.

What was perhaps regarded as the most important part of the act of incorporation is contained in section 3, and reads as follows:

> * * * the academy shall, whenever called upon by any department of the Government, investigate, examine, experiment, and report upon any subject of science or art, the actual expense of such investigations, examinations, experiments, and reports to be paid from appropriations which may be made for the purpose, but the academy shall receive no compensation whatever for any services to the Government of the United States.

This clause is still valid. The United States Government may at any time call upon the academy for investigations, opinions, and advice on any subject of science or art, and this without charge for services.

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In order the more clearly to understand the situation that existed in 1863, we should bear in mind two facts: First, there were at that time but few scientific bureaus forming parts of the National Government; and, second, it was a time of war.

Perhaps it would be better to state these facts in the other possible order. Service to the Government was uppermost in men's minds. If they could not help in one way, they could in another. What more natural than this willingness to place their knowledge and skill in scientific matters at the disposal of the Government? This was an act of patriotism, and patriotism was in the air.

While engineers, astronomers, and mathematicians were then well represented in the works of those who were serving their country in one capacity or another, it was a difficult matter for those in authority to secure authoritative opinions and advice in other branches of science. There was a gap to be filled. By granting a charter to a group of the leading workers in all branches of science on the terms under consideration, the gap was filled in what appeared to be a most satisfactory manner. After that act, there could no longer be excuse for not seeking scientific advice whenever it was desired or needed.

How did this work? An examination of the records shows that for a number of years after the National Academy was incorporated, the Government frequently called for reports. Six such reports were made in the first year of the existence of the academy. The subjects were:

"On the protection of the bottoms of iron vessels."
"On the magnetic deviations in iron ships."
"On an alcoholometer."
"On the explosion of a boiler on the United States gunboat *Chenango*."
"On the use of aluminium bronze for cent coinage."
"On wind and current charts and sailing directions."

In 1865 there were two reports; in 1866, four; in 1867, two, both of which are worthy of special mention. They are:

"On the improvement of Greytown Harbor, Nicaragua," and
"On galvanic action from association of iron and zinc."

In 1868 there were two. In 1870 there was one report, "On the protection of coal mines from explosions by electricity"; another, "On removal of ink from revenue stamps," and a third, "On silk culture in the United States."

In 1875 and 1876 there was only one each. Then in 1878 there were several important reports—six in all—among them one "On proposed changes in the Nautical Almanac," another "On the use of polarised light for determining values of sugars," another "On the measurement of the velocity of light," and another "On the preservation of the writing of the original Declaration of Independence." A

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second report on that subject was asked for only two or three years ago, and resulted in the consigning of the Declaration of Independence to a safe, where it would be protected from light.

While there have been important reports on important subjects since 1878, it is undoubtedly true that of late years the academy has been called upon less frequently than in the early years. At first the officers of the National Government took the matter seriously, and this was to the advantage of the country. But with the multiplication of scientific bureaus supported by the Government, the need of help from the academy has become less. While it is true that some of the subjects already mentioned, and others not mentioned, could have been reported upon by one or another of the bureaus now in existence, the conditions have changed, as already stated, but even as matters now stand, there is ample room for the kind of activity which was in the minds of the founders. Large questions of a scientific character present themselves from time to time, and it is hard to conceive of a better method of dealing with such questions than that under consideration.

* * * This is well illustrated by an actual case which deals with an important governmental problem. Owing to its importance, this case may well be treated of in some little detail.

The sundry civil act, approved May 27, 1908, requests the National Academy of Sciences to consider certain questions relating to the conduct of the scientific work under the United States Government, and to report the result of its investigations to Congress. In order that the subject may be clearly understood, the language of section 8 of the act referred to should be quoted:

SEC. 8. The National Academy of Sciences is required, at their next meeting, to take into consideration the methods and expenses of conducting all surveys of a scientific character, and all chemical, testing, and experimental laboratories, and to report to Congress as soon thereafter as may be practicable a plan for consolidating such surveys, chemical, testing, and experimental laboratories, so as to effectually prevent duplication of work and reduce expenditures without detriment to the public service.

* * * * * * *

As time passes it will come to be recognized more and more clearly by those in authority that the scientific method is the one most likely to lead to results of permanent value. Briefly defined, the scientific method consists in studying the facts and then drawing the most logical conclusion from these facts. It is most desirable that our Government should utilize to a greater and greater extent this method which is free from partisanship and has only truth to serve. In the long run the influence of the National Academy upon affairs of government must be felt.

Farsighted statesmen must see, and do see, that it is well for the country to have a body of workers in the field of science connected

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in some way with the Government, and the day will come when this will be recognized more clearly and more generally than it is to-day. The question is not what is best for the academy; it is what is best for the country. May we not hope that in the near future Congress will see its way clear to emphasize the importance of the connection between the Government and the academy by providing it with a proper home which can serve as a center of general scientific activity? This subject has again recently been brought to the front, and there is a possibility that favorable action may be taken.

By an act of Congress approved June 20, 1884, the National Academy of Sciences was "* * * authorized and empowered to receive bequests and donations and hold the same in trust, to be applied by the said academy in aid of scientific investigations and according to the will of the donors."

The funds under the general management of the academy, and their purposes, should receive some notice at this point in order that the work of the academy may be more clearly understood. I will go over this briefly. Some of them will be referred to at the time of the award of medals to-morrow afternoon. I do not wish to say anything that will necessitate repetition at that time.

First, there is the A. D. Bache fund. This amounts to over $50,000. It was provided by the will of Alexander Dallas Bache, one of the charter members, and the first president of the academy, who was for many years superintendent of the United States Coast Survey. The academy is trustee, and the income is applied to the prosecution of researches in physical and natural sciences.

Second, the Joseph Henry fund. This fund of $40,000 was contributed by a number of friends and admirers, as an expression of the donors' respect and esteem for Prof. Joseph Henry's personal virtues, their sense of his life's great devotion to science with its results of important discoveries, and of his constant labors to increase and diffuse knowledge and promote the welfare of mankind. The income was to be paid to Prof. Henry during his life, and after his death to his wife and daughters, and after the death of the last survivor, the fund is to be delivered to the National Academy of Sciences, the principal to be forever held intact and the income to be from time to time applied by the said National Academy of Sciences in its sole discretion to assist meritorious investigators especially in the direction of original research. Happily, this fund has not yet come into the possession of the academy. It is not necessary to remind this audience that Prof. Henry was for years the secretary of the Smithsonian Institution.

Third, the J. C. Watson fund. This amounts to $25,000, and was provided by the will of Prof. J. C. Watson, a distinguished member of the academy, who died in 1880. The income shall be expended

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by said academy for the promotion of astronomical science. It is also provided "* * * that the academy may, if it shall seem proper, provide for a gold medal of the value of $100, to be awarded * * * from time to time, to the person in any country who shall make any astronomical discovery or produce any astronomical work worthy of special reward as contributing to our science." Five medals have thus far been awarded, the recipients being B. A. Gould, Edward Schönfeld, Arthur Auwers, Seth C. Chandler, and Sir David Gill.

Fourth, the Henry Draper fund. This is the fund which makes possible the award of the Henry Draper medal, to be awarded tomorrow afternoon, with, no doubt, some explanatory remarks. The Draper medallists named in chronological order, are S. P. Langley, E. C. Pickering, H. A. Rowland, H. K. Vogel, J. E. Keeler, Sir William Huggins, G. E. Hale, W. W. Campbell,[1] and C. G. Abbot.

Fifth, the J. Lawrence Smith fund. In 1884 Mrs. J. Lawrence Smith, widow of one of our honored members, presented to the academy the sum of $8,000, the object of the gift being to promote the study of meteoric bodies, a branch of science which Dr. Smith had pursued with marked success. In accordance with the wishes of the donor, it was decided that a gold medal to be given as a reward for original investigations, would be most appropriate. Any excess of income above what is necessary for the striking of the medal, "* * * shall be used in such manner as shall be selected by the National Academy of Sciences in aid of investigations of meteoric bodies to be made and carried on by a citizen or citizens of the United States of America." Only one J. Lawrence Smith medal has been awarded. The recipient was H. A. Newton, and the medal was awarded for the investigation of the orbits of meteors. The income has otherwise been used to aid investigations, especially those of Prof. Newton.

Sixth, the F. A. P. Barnard medal. This medal is not provided for by a fund which was given to the academy, but the academy has the duty of naming the medalists. It is given every five years. It is not to be awarded this year. It was awarded in 1895 to Lord Rayleigh and William Ramsay. By the way, the money was left to Columbia University, of which Prof. Barnard was the president at the time of his death. The medal is awarded for meritorious services to science, to such person, whether a citizen of the United States or of any other country, as shall, within the five years next preceding, have made such discovery in physical or astronomical science, or such novel application of science to purposes beneficial to the human race, as, in the judgment of the National Academy of Sciences of the United States, shall be esteemed most worthy of such

[1] Omitted through oversight when address was delivered.

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honor. In accordance with these terms, the academy has recommended to the trustees of Columbia University awards of the Barnard medal as follows:

In 1895 to Lord Rayleigh and William Ramsay—now Sir William Ramsay—for their brilliant discovery of argon, a discovery which illustrates so completely the value of exact scientific methods in the investigation of the physical properties of matter.

In 1900, to Wilhelm Conrad Röntgen, for his discovery of the X rays.

In 1905 to Henri Becquerel, for his discoveries in the field of radioactivity.

In 1910 to Ernest Rutherford, for meritorious services to science resulting especially from his investigations of the phenomena of radioactive materials.

Seventh, the Wolcott Gibbs fund. When Wolcott Gibbs, who was one of the incorporators of the academy and at one time its honored president, reached the age of 70 in 1892, a number of friends presented him with a sum of money to establish a fund bearing his name, the income to be devoted to aiding in the prosecution of chemical research. Dr. Gibbs presented this fund to the academy, the income to be administered by a board of directors, who "* * * shall have absolute and entire control of the disposition of the income of the fund, employing it in such manner as they may deem for the best interest of chemical science."

Eighth, the Benjamin Apthorp Gould fund. This was given by Miss Alice Bache Gould, daughter of the distinguished astronomer, Benjamin Apthorp Gould, one of the incorporators of the academy, who died in 1896. The amount was $20,000, given as a memorial of the life work of her father, the income to be used for the prosecution of researches in astronomy.

Ninth, the Cyrus B. Comstock fund, which came into our possession in 1907. The prize in money has not been awarded thus far, but will be awarded at the meeting at the White House to-morrow, and explanatory remarks made at that time. Gen. Comstock was a distinguished engineer and member of the academy, who died in 1910.

Tenth, the O. C. Marsh fund. Prof. Marsh, for 12 years president of the academy, died in 1899. He bequeathed the sum of $10,000 to the academy, the income to be used and expended by it for promoting original research in the natural sciences. This fund has not yet become available.

Eleventh, the Alexander Agassiz fund. Alexander Agassiz, who was president of the academy from 1901 to 1907, died in 1910, and bequeathed to the academy the sum of $50,000, unconditionally. No decision has yet been reached in regard to the uses to which this fund is to be put.

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And, finally, the Agassiz medal, which will be awarded for the first time this year, was provided for by a gift of Sir John Murray.

While this account may have proved tedious to some of you, it seemed necessary for the purpose of giving a correct impression of the work being carried on. The academy has sacred duties to perform. It will soon devolve upon the younger members to see that these duties are conscientiously performed.

The constitution provides that the academy shall hold one meeting each year in the city of Washington and another at such place and time as the council may determine. Whatever may be said of the duties of the academy as the scientific adviser of the Government, and as a custodian of trust funds, it must be acknowledged that it is through the agency of its regular meetings that its influence is mainly exerted. In this, as in other matters, it is the subtle, the intangible, the spiritual that tells.

Workers in the field of science are supposed by some—perhaps by many—to be incapable of recognizing the force of the intangible, and yet scientific work must inevitably lead to this recognition. It is impossible to weigh and measure the effect of the meetings upon those who take part; but that effect is felt none the less, and it is certain that those who attend are in the long run benefited, some in one way, some in another.

This is not a subject that lends itself to profitable discussion. It may not be out of place, however, for one who has been a regular attendant for more than thirty years to make public acknowledgment of the debt which he personally owes the academy for the opportunities it has afforded him of associating with and counting among his friends those whose earnest, honest work has been an inspiration to him and to the world. This association has been an inestimable privilege, for which he is deeply thankful.

The work of the academy will continue; new and younger members will take up the work. Is it too much to hope that when the centennial anniversary is celebrated some of the members here present may be remembered as we to-day remember, with gratitude, our founders?

ADDRESS OF PRESIDENT ARTHUR T. HADLEY, OF YALE, ON "THE RELATION OF SCIENCE TO THE HIGHER EDUCATION IN AMERICA."

The half century which has elapsed since the founding of this academy has witnessed, as we all know, a radical change in the relations between science and education. This change is equally marked in professional training which prepares students for their several callings, and in the general training which prepares them for the duties and enjoyments of citizenship.

Fifty years ago the professional study of science in our universities was confined within very narrow limits, surprisingly narrow to those

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who see those places as they are to-day. There was no room for science in the schools of theology or of law. Schools of philosophy, in the modern sense of the word, had hardly developed. Even in schools of medicine, where among the universities the study of natural sciences first gained a foothold, there was relatively little of scientific method as we to-day understand the words, either in the teaching or in the study. There was much more learning of names of things and much less learning of reasons of things; much more of tradition and much less of investigation. The anatomy and chemistry of the medical schools of those days were good sciences, as far as they went, but they generally did not go very far. As to the use made of it, there is truth in the remark of one of my former colleagues that down to a recent day the three learned professions of theology, law, and medicine had not advanced far beyond the old conception of the magic of the tribal medicine man, that the important thing for science to do was to find proper formulas of exorcism with which to banish evil spirits from their several realms of action.

Outside of the universities, a half century ago, things were little or no better. There was a small number of schools of engineering and a still smaller number of schools of chemical technology, but they did not form part of a large scheme of business training as a whole for the nation. The trained engineers of the first half of the nineteenth century were, as a rule, engineers trained in military schools. Most of the civil engineers, as we called them by contrast in those days, had learned their profession in the field. Most of the technologists had learned it in the shop. Now, all of this has changed during the 50 years of the life of the academy, and changed radically. Our universities have developed scientific study in all their departments, and especially so in their schools of medicine and philosophy. And side by side with these universities, schools, or faculties there have grown up colleges of engineering and technology, sometimes in connection with the university, sometimes outside of it, which lay a scientific foundation for a calling that only a few years ago was thought to need no scientific foundation at all. For the world has found a place for the scientific expert in every line and is inclined to regard as the best school, not the one that has the most students, not even the one that can give the best general education, but that which in the different lines can train and furnish scientific experts of the highest rank and most varied knowledge.

For civilized nations have at last come to the conclusion that the old supposed antagonism between theory and practice was a misleading conception, and the habit of drawing a sharp line between the theoretical man and the practical man was a pernicious one.

Fifty years ago a man who had obtained all his knowledge of his business by his own experience was habitually proud of the fact; he

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was, as the phrase went in those days, a self-made man who spent most of his time in worshipping his Creator. He counted it a matter of superiority that he knew nothing except what he had found out himself and taught himself. To-day it is recognized that every man can learn from the theorist that there is room for the application of scientific principles in every department of life; that the farmer, the manufacturer, or the merchant, no less than the engineer or the physician, must prepare to avail himself of the theory which has been built up by investigators, which has been taught in laboratories and incorporated in books, if he would bring his practice up to the needs of the time.

Of all the conquests of modern science, there is none which, in my judgment, is more remarkable or significant than this conquest of current business opinion. We no longer draw a distinction between learned and unlearned professions. We have recognized that every profession and every trade, in order to be pursued to the best advantage, must be a learned one. None so complex as to be unable to get help from science; none so simple as not to need it. We have shaped our system of technical training accordingly; and we have learned to rate at their true worth the men and the places that can give training as research institutions, side by side with universities which make progress in such training possible.

Equally important, though of a different and perhaps less wholly satisfactory character, has been the change in the scheme of our general education, in the choice of subjects and methods of teaching offered in preparation for the general work of citizenship as distinguished from the preparation of each man for his business or calling.

The old course of study in our high schools and colleges consisted chiefly of classics, mathematics, and metaphysics, with a little history and a few descriptive courses in natural science. Of scientific training in the modern sense it gave none, except to the unusual man whose mathematical tastes made the study of algebra and analytical geometry a means of scientific education in spite of textbook and instructor or classroom atmosphere, or the still more unusual man who used his grammar and metaphysics as an exercise in closely ordered reasoning. The course as a whole was constructed for the man whose interests were in the past rather than in the present and the future. The training which it gave—good, in many respects—was a training in memory, in expression, and in accuracy of apprehending language, one's own or another's, rather than in scientific method as we understand it to-day.

There is on the façade of the main hall of a university which has done much for education in many lines, a representation of Philosphy in a dominant central position—old-fashioned metaphysical philosophy—with the different sciences laying tribute at her feet. I suspect

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that this is not an unfair characterization of the views as to the place of science in education which prevailed among most college faculties a generation or two ago.

Now, let me say right here that I do not for a moment overlook the advantages of the old system. It taught the boys to use books and find things out from books, and to expect to do hard work for that purpose instead of to have somebody else make it easy. This was a great merit, and the boys trained under the old system showed this merit. But college faculties were often blind to the particular kind of book learning and to the general kind of book learning that was most important for human progress and which was of most concern to the living world outside.

For at the time when the academy was founded, and in the time since, chemistry and physics and geology and biology were becoming not only matters of importance to the experts in their several callings, as I have indicated, but matters of real and dominant interest to intelligent men who were not experts, but who cared for knowledge and who cared for current history. A large section of the world, an increasingly large section of the world, cared more for books that explained the tendencies of the present than for those that embodied the ideals of the past. Perhaps this movement may have gone too far and may have caused people to care too little for the ideals of the past, to overvalue scientific reading as compared with historical or literary reading. I shall not try to discuss whether it did or not. At any rate, a curriculum which was exclusively occupied with classics and philosophy did not fully meet the demands of grown men or the needs of boys, and inevitably the course of study in our colleges had to be remodeled accordingly.

Each decade of the last 50 years has witnessed a gradual crowding out of classics from our older schools and colleges by subjects of new and more present interest, and a growth of new schools and colleges of a different kind, where science in varying forms is made the chief subject of attention and other matters relegated more or less to the background.

Now this increasing interest in science is a matter about which we may all, members of the academy, and guests of the academy, scientific men and literary men, rejoice heartily. But how far the things that are called science deserve the name of science, or how far the teaching of such subjects by present methods always deserves the name of education, is quite another question. Every school superintendent likes to stimulate the attention of his pupils by giving them the opportunity to see amusing phenomena with their own eyes, and if possible set them in motion with their own hands. Under some circumstances this may be the best kind of scientific training; under other circumstances it may be no training at all.

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Nature study—to quote a phrase which is popular among educators of the present time—is good if it is made the basis for teaching scientific methods, and bad if it is simply made a means of momentary amusement. Unfortunately, a large part of our school committees and schoolteachers think that the subject makes the science. They may not go as far as the author of a reputable work, "Murray's Handbook to Spain," who says that the mountains of that country, to quote his own words, "abound in botany and zoology." They are apt to assume that the picking to pieces of flowers is in itself botany, and that hearing a carbon disulphid mixture make a loud explosion, marks progress in chemistry, and to act accordingly.

Fifty years ago the members of the National Academy of Sciences who held seats in college faculties were occupied in protecting science against its enemies. I am not sure but what to-day their chief duty lies in protecting it against its friends.

When the National Educational Association says that high schools should be encouraged to omit the study of algebra and geometry, and that the colleges should be compelled to accept for admission an equivalent amount of "science"—God save the mark—it is time for the true friends of science to call a halt.

I may say in parentheses that only the other day the school superintendent in one of our more newly developed parts of the country said he had to make a change because it was so easy to find thoroughly competent teachers of physics, but that so few of them ever knew any algebra. For the importance of scientific training to the student in our high schools and colleges is not due primarily, or in large measure, to the facts of physics or biology that he learns in the school. It is due to the training in certain habits of observation and deduction in certain methods of hypothesis and verification, which he can get more effectively by a good course in science than by one predominantly devoted to languages, where the scientific training is merely incidental. That the facts of physics or biology are more interesting to the student of the world than those of Latin and Greek and have more obvious bearing on everyday life is a help to the teacher in securing the voluntary cooperation of the pupil; but it is far from being the fundamental reason why the subjects themselves are educationally valuable. It is not the subject that makes the course scientific; it is the method.

You have been good enough, Mr. President, to refer to my father's connection with the academy, and I for my part am glad to take the opportunity to say that he regarded his election to membership in this body as the greatest honor he ever received. I feel sure, therefore, that I shall be pardoned if I illustrate the point I have just made by reference to my father's teaching.

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Fifty years ago the one course in the academic department of Yale College, where modern science was really taught, was the course in freshman Greek. For my father, though he had the highest enjoyment of classical literature, was, by training and temperament, a philologist; and he taught the freshmen who came under him to take Greek verbs to pieces and compare and observe their parts and put them together again, and see what principles were involved in the analysis and synthesis, exactly as the botanist may have done with his plants or the chemist with his elements.

In those days chemistry and physics were taught in Yale College, as distinct from the Sheffield Scientific School, solely by textbooks and lectures. Philology was taught by the laboratory method, and for that reason the freshman Greek course was a course in modern science, and meant that to the pupils.

The courses in chemistry and physics widened the boy's knowledge of facts and doubtless encouraged many of them to get scientific training for themselves afterwards; but the course in freshman Greek for the first term was a course in science, because the boys learned to do the things, both easy and hard, which are the heritage of the man of science.

Science is not a department of life which may be partitioned off from other parts; it is not the knowledge of certain kinds of facts and the observation of certain kinds of interest as distinct from other facts and other interests; it is a way of looking at life and dealing with life; a way of finding out facts of every kind and dealing with interests as varied as the world itself—

> Where each for the joy of the working, and each in his separate star,
> Shall draw the thing as he sees it, for the God of things as they are.

ADDRESS OF DR. ARTHUR SCHUSTER, SECRETARY OF THE ROYAL SOCIETY OF LONDON, ON "INTERNATIONAL COOPERATION IN RESEARCH."

The intellectual activity of the world, scientific, literary, or emotional, passes alternately through fertile and through barren periods. Each fertile period has its characteristic peculiarities and though any one generation may not be competent to form a just estimate of its powers and effects, it is able to compare the fruits of its own labors with the harvest of its predecessors. You will probably agree with me that our age is distinguished by having disclosed a vast array of facts which take us nearer to the infinitesimal structure of matter and which reach further into the infinite design of the universe than the boldest flight of imagination could have foreseen half a century ago. But we do not flatter ourselves that the intellect of our time, judged by the power of individuals, is exceptionally great. No doubt, men of commanding genius are still with us, but they are not more numerous or more original than in former times. What then is the peculiarity that has produced such great results? In my opinion

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what has been accomplished is due in great part to the spread of higher education, which has evolved an army of competent investigators possessing enthusiasm for research which now, for the first time, is led into useful paths by the few great minds, whose powers thus receive a wider range and become more productive. It is in this that our great strength lies.

The functions of an organization devoted to research are to take full advantage of all available mental resources. Intellect can not be artificially created nor can originality be taught, but whatever intellect and originality exists may be directed into fertile channels, so that those who have the gift of connecting facts shall not fail because the facts are not available.

The advance of science demands that experiment or observation and theoretical discussion should advance in parallel lines. Without organization, one of the teams on whose joint exertions the advance depends, is likely to outrun the other. Thus Newton, when he had formulated his law of gravitation, which connects the orbit of the moon with the acceleration of falling bodies, did not publish his discovery for many years, because he could not verify his theory as closely as he desired. It was only after the French Academy had accurately measured an arc of meridian and had discovered a substantial error in previous measurements that Newton's law of gravitation could be said to be proved. In this case theory had gone ahead of observation; but examples of the opposite kind will not be wanting so long as we have observers concerned entirely with the accumulation of data, content to leave discussion to the dim future. It is one of the objects of organizing science to bring the two factors to bear on each other.

International cooperation in research is necessary because scientific inquiries can not be divided into compartments limited by political boundaries. The very language which we use to express our thoughts is tied down by conventions, some of which we have absorbed as students, but which in the case of new branches of learning have formally to be agreed upon. Our measurements—and all accurate science depends on measurements—have to be expressed in units, and how are these units to be fixed except by agreement? While this will be acknowledged by everyone, it is not equally recognized how much our present refinements in scientific research depend on organized efforts. Whether these efforts should be concentrated in a single laboratory or confined within one political unit or carried out by the combined scientific community of the world, mainly depends on the nature of the problem.

It is not my purpose to trace in detail the history of international problems and international organizations; but rather, to show the great variety of problems in which useful results have already been

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achieved by international cooperation, and to bring the lessons of the past years to bear on the future.

I divide international cooperation into three categories:

1. Agreement on standards and units of measurement.

2. The distribution of work bearing on the same problem, between different nations, for the purpose of economizing time and expenditure.

3. The investigation of problems which can not be solved unless observations made with identical or similar instruments are obtained from different parts of the world and the records published in a homogeneous form.

I think all are agreed as to the question of units and I need not detain you by giving you an account of the various international conferences which have been held and agreements which have been arrived at on these matters.

As regards problems of the second category, they are those which deal mainly with the cosmos as a whole because their solution depends so much on the collection of statistics which exceeds the powers of individuals or even of single nations. A few examples may illustrate what has already been accomplished. First, and foremost, we have the great Star Catalogue, initiated at an international congress 25 years ago, when 18 observatories combined to divide the work, each taking a number of zones in the heavens.

The importance of this work will be plain to everyone, and we must regret that it is still so far from being completed.

As it is not my intention simply to point out the merits of international work, but also to point out its difficulties, a few words may be said which are not intended as criticism, but which may serve to point out the weakness which arises when there is no central authority which lives longer than the single individual can expect to live.

Pioneers will always be found to initiate a work, but in time they die or retire from office; others take their places, and if these become more interested in fresh problems the work suffers unless it is effectively impressed on their attention by some permanent body. Where to find such a central body, whose main functions would be to endow an undertaking with sufficient inertia to carry it over periods in which the work may seem to be a drudgery, is a matter which deserves careful consideration.

The completion of the Star Catalogue, which has given rise to these remarks, is only the beginning of an even greater piece of work. When we have determined the positions and magnitude of stars at any one time, we have only taken the first step toward solving the main problem, and must proceed to measure the proper motions, the parallaxes, and also map the spectra. This work is so vast that all hope to accomplish it within reasonable limits is difficult and has to

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be abandoned unless our statistical ambitions are lowered, and instead of taking the complete sphere of the heavens we select restricted but typical areas for detailed examination. This has been done on the initiative of Prof. Kapteyn, who has secured a sufficient number of voluntary associates who are now carrying out a combined undertaking which has already yielded results of the greatest importance, and you will hear something more of this work from his own lips.

Now the essence of work of this kind consists in shortening the time required to accomplish an extensive task by dividing it among a number of persons. If the work is purely statistical, it may be complete in itself, and the published records become then available to anyone who requires them. In other cases the observations may have to be collected by a central authority and treated by recognized methods of statistics or analysis before they become useful to the scientific public. While it is generally the observational portion of the work that is subdivided and the discussion that is centralized, the reverse is the case in the proposal made by Prof. Pickering—that one central observatory in a favorable position should furnish photographs in sufficient numbers and distribute them among astronomers all over the world, to be measured and discussed.

Finally, a great undertaking of quite a different character—the International Catalogue of Scientific Literature—must be classed in the same category. This catalogue has arisen out of a desire to classify the scientific literature of the world, so as to enable anyone who desires to study a certain subject, to find out quickly all previous researches relating to it. Practically all nations in which scientific work is carried out have united, each collecting its own data and forwarding it to the central bureau in London.

I can not pass away from this type of international cooperation without expressing regret that a proposal which was made by the late Prof. Simon Newcomb has not been adopted hitherto. When the first program of the Carnegie Institution of Washington was being discussed, he proposed that there should be some central computing bureau established at one place where accumulated data of observation, which required scientific treatment, could be discussed and treated in that way. The number of instances which have come to my own notice within the last few years, in which the existence of such a bureau would have been of the greatest assistance to the progress of science is considerable; and I feel very little doubt that others have also felt the want.

The problems which fall into the third category are mainly those belonging to the important and much neglected subject of geophysics. The time is passed when we could separate the physics of the laboratory from that of the earth, and that again from the physics of the universe. The experimenter who now studies the structure of the

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atom must keep an eye on the sun and stars in order to detect whether celestial observations destroy his theories or give them strength.

Atmospheric electricity and terrestrial magnetism, treated too long as isolated phenomena, may give us hints on hitherto unknown properties of matter. A meteorologist, finding out at last that space has three dimensions, and that the motion of air is governed by the laws of mechanics, has converted what hitherto has been a sport into a science.

Before enumerating the international associations which are dealing with these problems of geophysics, let us say a few words as to the problems themselves.

We have, first, to study the shape of the earth and the variations in the gravitational forces which are observed on its surface. We have further to take account of the secular variations of level and of the more or less violent disturbances which accompany earthquakes and earth tremors. By comparing the indications of instruments placed in different localities, we can deduce the rate of propagation over the earth and through the earth of the seismic waves. This yields us important information on the physical properties or material composing the interior of the earth. The cause of terrestrial magnetism is at present unknown, and we have no means at our disposal to attack the problem directly, but the study of the diurnal and secular variations may give us a clue, and deserves our closest attention.

In a similar way, the study of the higher atmosphere and of the high electric conductivity which the air is now known to possess at heights which we can not reach, is also a subject which can only be studied by combined efforts. How are these questions dealt with at present?

We have, first, an International Association of Geodetics, which is an exceedingly efficient body, with a bureau at Potsdam, under Prof. Helmert. That association is successful, perhaps, partly because its work has been facilitated in that it had to build on virgin soil. Nothing had been done, to a very great extent at any rate, internationally before that association came into being. On the other hand we have the International Association of Seismology, a related subject, which was only founded at the beginning of the present century, with a central bureau at Strasburg. This association had to overcome more serious difficulties. It entered into the field when there was already a less extensive organization in existence, which had been originated by Prof. Milne and was directed by a committee of the British Association. The question of instruments also presented peculiar difficulties, which it is hoped may soon be overcome.

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As regards terrestrial magnetism, I have only a few words to say.

Through the magnificent efforts of the Carnegie Institution of Washington, we are at last likely to have a satisfactory magnetic survey of the world, but important as the results obtained by Prof. Bauer in the *Carnegie* will prove to be, they will have to be supplemented by systematic observations of the variations of the magnetic forces at a number of fixed stations. Many such stations are in existence, though they are very irregularly distributed over the surface of the earth.

In this subject, almost more than in any other, an international agreement on the manner in which the records are to be treated and published is essential, and it is much to be regretted that the attempts that have been made to reach such agreements have not met with greater success. There are, no doubt, peculiar difficulties due to differences in the organization of the magnetic services.

Methods have developed independently in different countries, and there is a natural but regrettable reluctance to alter an instrumental detail or a peculiarity in treating the observation until the necessity of the change has been demonstrated. But that can never be done, because practically all methods are equally good. What is bad is that they differ. Almost any one of these methods could be adopted with advantage anywhere, so that a discussion of which of the methods is better than the other is futile. The first essential then is that in every place on earth the same methods should be adopted, because the least difference in them may cause important errors in the deductions when they come to be compared with each other.

The only body which at present deals systematically with the records of terrestrial magnetism is a subcommittee of the meeting of directors of meteorological observations. The directors of meteorological observations, meeting at intervals, have appointed a certain number of subcommittees dealing with a certain number of subjects. Some of these overlap other associations already. So that, for example, the question of solar radiation falls partly under that subcommittee of the directors of meteorological observations and also under the International Solar Union, a union which has been founded by your foreign secretary, Prof. Hale.

The present international organizations differ considerably in the manner in which their expenditure is provided for. The International Geodetic Association, the Association of Seismology, and the International Bureau of Standards are directly supported by the governments, the contributions depending upon the population of each country and amounting, for the larger ones to—I need not give you the figures now. They are of no particular interest.

The International Catalogue of Scientific Literature is a very costly undertaking, and that is provided for by each country guaranteeing

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the sale of a certain number of copies, a capital fund having been paid to start the organization by the Royal Society of London.

In the case of the great Star Catalogue, each observatory is responsible for its own expenditure. The four French observatories have received Government contributions amounting together to over $500,000. In England a much smaller sum has been given, and in other countries the work has languished a good deal because sufficient funds were not available.

The Solar Union has no funds whatsoever and is even unable to pay for its own publications. Sufficient has been said to show how wide a range is already covered by international research. Further extensions of the work are constantly being called for, and we are brought face to face with the problem that separate associations can not be multiplied indefinitely without introducing difficulties which, as their number increases, endanger the objects which they are intended to serve. Apart from the overlapping of interests and questions of finance, the time spent in correspondence and administration is already serious. The nature of the problems suitable to be dealt with by international efforts is such that the same persons are generally interested in several of them, and the meetings succeed each other so rapidly as to become a serious tax on the time of those who attend them and some who used to look with favor on international work are beginning to be frightened.

Perhaps we may look forward to some arrangement to combine the meetings of the different associations in the manner of the different sections of the British Association, for instance. But this would require some central authority to act as a bond between the bodies which at present are separate and independent.

Economy of working, both financial and administrative, points in the same direction, and we are driven to the conclusion—and that, I think, I should like to make the moral of this paper—that the present policy of establishing a separate association for each new extension of international work should be reconsidered and an effort made to economize time in working and administration by some larger scheme including the various separate international institutions on related and similar subjects.

Realizing that it is necessary to take some action in this direction, yet perhaps not understanding correctly why the action is necessary, an ambitious undertaking has been evolved in Belgium, where it is proposed to erect an office uniting all international associations, whatever their object or character may be. The promoters have drawn up their statutes, one general congress has already been held, and another is now being organized.

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Our work is sufficiently difficult, if we confine ourselves to scientific methods. It nevertheless remains true that it is desirable to establish some central authority which can act as a connecting link between different associations. What should its functions be? It is the essence of all international combinations that they depend entirely on moral force and have no power to impose their decisions. A central authority must therefore be content with offering advice, with the conviction that, if the advice is sound, it will be accepted.

Though the existing associations would tolerate no interference with their independence, they would doubtless consider with care any suggestions made to them in the interests of science by an authoritative body. Our problem is therefore to find an authority of sufficient eminence to be generally looked upon with confidence and who could also act as adviser to different governments when they are asked to financially support some fresh undertaking. That is one of the most serious difficulties of the present time. There is a new international undertaking proposed almost every year, and application is made to the different governments for support and money. What is the Government to do? To whom is the Government to go for advice whether such an undertaking is worthy of support or not? My solution of that question is this: In the International Association of Academies we possess indeed a body fulfilling all the requirements of such a central authority, provided the individual academies constituting the association are willing to undertake the task. The Association of Academies was founded at a conference held at Wiesbaden on the 9th and 10th of October, 1899, the National Academy of the United States being represented by Profs. Newcomb and Bowditch. The paragraph of its statutes which were adopted at a meeting held in Paris in 1901 relating to the functions of the association runs as follows:

> The object of the association is to prepare and promote scientific work of general interest which has been submitted to it by one of the associated academies, and to facilitate in a general manner scientific intercourse between different nations.

From its origin the association claimed an advisory voice in new international undertakings, and at the meeting held in London in 1904 the following resolution was passed with one dissenting voice:

> That the initiation of any new international organization to be maintained by subventions from different States demands careful previous examination into the value and objects of such organizations, and that it is desirable that proposals to establish such organization should be considered by the International Association of Academies before definite action is taken.

After a period of activity ranging over about 12 years it may be useful to review the work which has been accomplished, but I shall confine myself to the record of its section of science, remarking only that the section of letters has also much important work in hand.

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The powers of the association are purely advisory; it has no funds at its disposal, and for this reason alone is unable to initiate or support any scientific enterprise unless the individual academies provide the expenditure, as is being done, for instance, in the publication of Leibnitz's works, which has been undertaken by the academies of Berlin and Paris jointly. A complete map of the moon with its features named according to an agreed scheme is in process of preparation and is welcomed by students of the lunar surface. Among the subjects which have been treated, the excellent work done by an autonomous committee appointed to investigate the functions of the brain should also be referred to; and there are a number of various committees which have done good work.

In many cases the association has been called upon to express a favorable opinion on the importance of some international scheme which is independently being pressed upon the consideration of one or more Governments. To deliver a platonic blessing is so gratifying a task that applications for it are not perhaps always scrutinized with sufficient care, though I admit that it is better to support a doubtful enterprise than to risk stopping a good one.

The association has been most successful when it has used its influence to press important scientific objects on the attention of their Governments. It is in part, at any rate, due to their recommendation that money was found for the measurement of the great arc of meridian, which, covering 105°, stretches through Russia and Roumania and continues through Asia Minor and Western Africa, to the Cape of Good Hope. This is a continuous arc of meridian reaching from the north of Russia to the Cape of Good Hope in which a number of Governments, the British Government, the German Government, the Russian Government, and the Turkish Government are involved, which is in process already, and is really nearing completion.

It has become the practice during recent years that international organizations established independently place themselves under the protection of the Association of Academies, to which they report periodically. Though the academics exercise no control over such bodies, they stand to them as a reserve power willing to help when required.

In all these respects the association has fulfilled the intention of its founders, but has it left its mark to any appreciable extent on the progress of science? Without wishing to underrate the good that this body has done in the past, I do not think I stand alone in hoping for a wider activity in the future, and I doubt whether it will long maintain its vitality unless it extends its ambitions as it passes from the age of youth to that of manhood. This is a critical period in its history, and much will depend on the policy it will adopt on a question which may still be kept in abeyance for a short time, but which will have to be faced before long.

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An international organization which has no central office and is not domiciled in any country is not a legally constituted body. It possesses no property. It can not accept gifts or legacies. The question has been repeatedly raised whether it is desirable to remove this restriction and to establish the association on a legal foundation. For this purpose it would have to place itself under the laws of some one country, and the selection of that country complicates the decision on the main issue, as national consideration and perhaps to some extent national jealousies have to be taken into account.

To clear our minds, let us separate the two issues, that of the power to hold property and that of a permanent domicile. Each academy knows from its own experience that though individual research may often be carried out at a small cost an organized investigation demands funds which become considerable when its range is wide. It is therefore just the type of work that an international organization is best fitted to undertake which demands the greatest amount of assistance.

The question to be faced is this:

Shall our International Association be forever content to exercise a purely platonic patronage, or shall it take an active part in promoting research? If it chooses the latter course it seems to me to be indispensable that it should have funds at its disposal.

I advocate the bolder policy on two grounds: Firstly, international research is most logically administered and paid for by international funds and, secondly, it seems to me that a purely moral support can not in the long run remain effective. The existing special associations, as I have already stated, must retain their complete independence and it is not likely that it will ever be desirable that the Association of Academies should undertake any work in which financial support is expected to extend over a considerable period; but when promising enterprises are in their experimental stages, funds are often most urgently required and most difficult to obtain.

It is here that an international body, having an independent income, could most efficiently step in to support meritorious enterprises during the few critical years until they can be either established on a permanent basis or have completed their work.

I recognize of course the weight of certain objections which have been raised, but I think we must run the risk all the same, for my experience teaches me that there is seldom any vitality without antagonism; and the main ground of objection is that we are going on so nicely, we never disagree and therefore we had better remain as we are. But after all, our progress is only obtained by those having differences of opinion coming together and adjusting their differences.

Even should the general opinion be against me, and if it were definitely decided that the International Association of Academies should

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forever maintain its present state of poverty, the establishment of a domicile on a moderate scale will have to be considered as an independent issue. It might be mentioned that in the original proposals of the Berlin Academy, they intended that there should be not only a central bureau but an organ, published monthly or quarterly, giving an account of the work done by any one academy that would interest the other academies.

The policy which the International Association of Academies will adopt on these questions is one of the most vital importance, for not only will the future of international work depend on the course taken, but the reputation and influence of the academies themselves will, I am convinced, be seriously affected by the decision.

It is with the greatest hesitation and with much diffidence that I now approach the concluding portion of my discourse, for I am oppressed by the fear that my remarks may be taken as an unnecessary interference in the concern of others. But the issue is too serious to let that prevent my expressing an opinion which is based on a deep, and I believe impartial conviction.

The academies, royal societies, or whatever name they are called by, have been founded at different times in accordance with the varying requirements of their countries. They value their historical traditions above everything; some are over 200 years old, others of recent growth, and their constitutions differ in many respects. But whatever their constitution and their history may be, they must be judged by this same test: Do they fulfill their obligations, which for all of them, I take it, is that defined in the charter of the Royal Society as "The promotion of natural knowledge?" Do they embody in themselves the promotive power of the scientific efforts of their country, or have they fallen a prey to the dangers, which more especially beset the older institutions, of crystallizing into an aristocracy of science, recruited from those who in the natural course of growing maturity are ceasing to be active workers and constitute themselves to be the judges of the work of others? The dead weight of such a society, brought to bear discreetly on the exuberance of youth may have its uses, but it remains a dead weight just the same. It should act as a brake on a too fanciful imagination, but it can take no share in any real progress. If the academies are to fit themselves for the formation of a really strong and fruit-bearing association they must be bodies which, animated, as all of them now are, by the highest and noblest ideals, strive at the same time to represent what is best and most progressive in the scientific life within their range of influence.

Each country must solve its own difficulties, but in addressing your National Academy which, though it holds to-day its first jubilee, may still be called youthful, I may be forgiven if I remind you that,

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while the older institutions may offer you much that deserves to be admired and perhaps be imitated, you must not mistake the signs of gray hairs for the stamp of an enviable dignity.

This, then, is my final summary. Ours is an age of organization presenting many problems that can not be confined within political boundaries. The demands of science have already called into existence separate international associations, which are efficiently performing their duties. Nevertheless the continued increase of their number is beginning to cause inconvenience and is likely to hamper future developments unless they can be united by some bond intended to coordinate their work. The International Association of Academies stands out as a natural body, fit to act as a central advisory authority. To exercise that authority effectively, the academies must individually recognize their obligations to be truly representative of the most healthy and vigorous portion of the scientific life of their country. It is because I believe in the vitality of the academies and in the power which an increased responsibility will give them to check the danger of stagnation to which ancient and dignified bodies are exposed, that I advocate the extension of their activity and the more vigorous exercise of the dormant power which resides in the union of the illustrious bodies which together constitute the International Association of Academies.

ADDRESS OF DR. GEORGE ELLERY HALE, DIRECTOR OF THE MOUNT WILSON SOLAR OBSERVATORY, ON "THE EARTH AND SUN AS MAGNETS."

In 1891, Prof. Arthur Schuster, speaking before the Royal Institution, asked a question which has been widely debated in recent years: "Is every large rotating body a magnet?" Since the days of Gilbert, who first recognized that the earth is a great magnet, many theories have been advanced to account for its magnetic properties. Biot, in 1805, ascribed them to a relatively short magnet near its center. Gauss, after an extended mathematical investigagation, substituted a large number of small magnets, distributed in an irregular manner, for the single magnet of Biot. Grover suggested that terrestrial magnetism may be caused by electric currents, circulating around the earth and generated by the solar radiation. Soon after Rowland's demonstration in 1876 that a rotating electrically charged body produces a magnetic field, Ayrton and Perry attempted to apply this principle to the case of the earth. Rowland at once pointed out a mistake in their calculation, and showed that the high potential electric charge demanded by their theory could not possibly exist on the earth's surface. It remained for Schuster to suggest that a body made up of molecules which are neutral in the ordinary electrical or magnetic sense may nevertheless develop magnetc properties when rotated.

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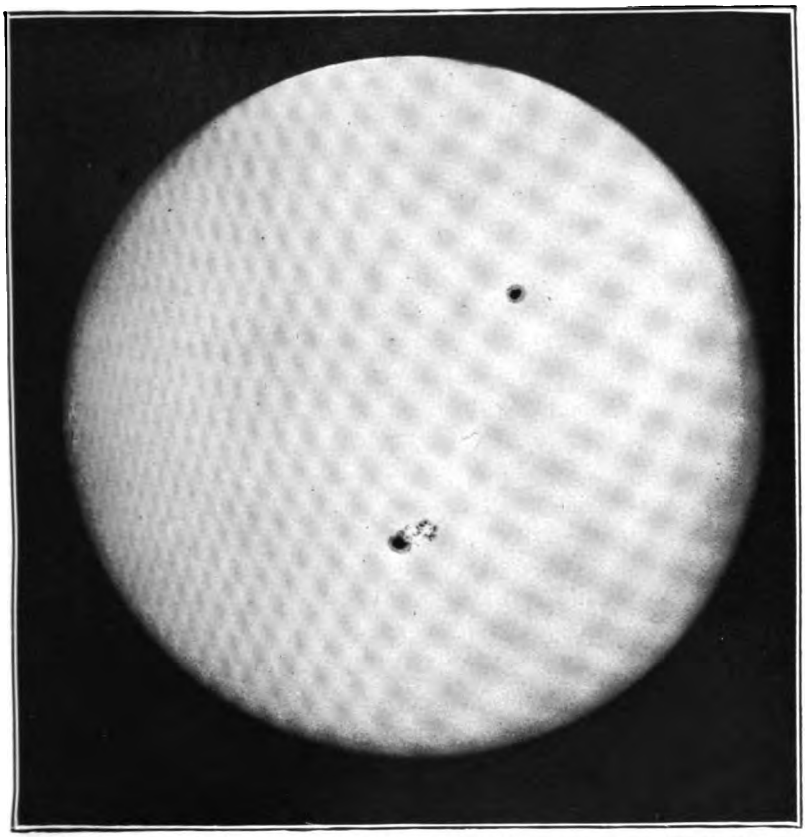

FIG. 1.—DIRECT PHOTOGRAPH OF THE SUN WITH DOT REPRESENTING EARTH FOR COMPARISON.

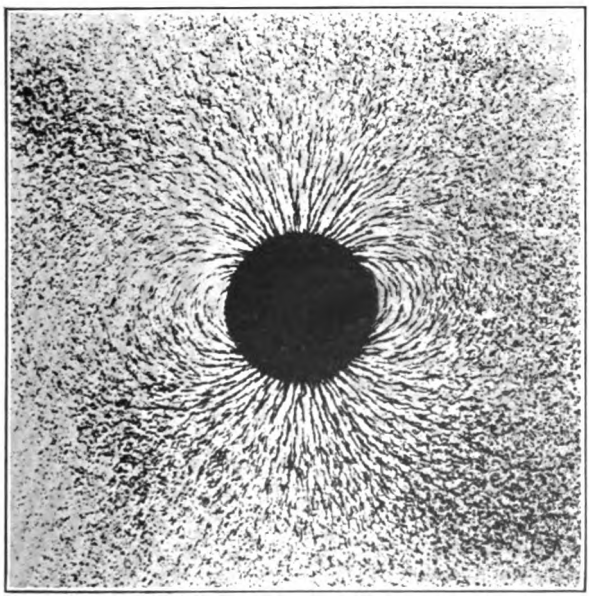

FIG. 2.—LINES OF FORCE OF A MAGNETIZED STEEL SPHERE.

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We shall soon have occasion to examine the two hypotheses advanced in support of this view. While both are promising, it can not be said that either has been sufficiently developed to explain completely the principal phenomena of terrestrial magnetism. If we turn to experiment, we find that iron globes, spun at great velocity in the laboratory, fail to exhibit magnetic properties. But this can be accounted for on either hypothesis. What we need is a globe of great size, which has been rotating for centuries at high velocity. The sun, with a diameter one hundred times that of the earth (fig. 1), may throw some light on the problem. Its high temperature probably precludes the existence of permanent magnets; hence any magnetism it may exhibit is presumably due to motion. Its great mass and rapid linear velocity of rotation should produce a magnetic field much stronger than that of the earth. Finally, the presence in its atmosphere of glowing gases, and the well-known effect of magnetism on light, should enable us to explore its magnetic field even at the distance of the earth. The effects of ionization, probably small in the region of high pressure beneath the photosphere and marked in the solar atmosphere, must be determined and allowed for. But with this important limitation, the sun may be used by the physicist for an experiment which can not be performed in the best equipped laboratory.

Schuster, in the lecture already cited, remarked:

> The form of the corona suggests a further hypothesis which, extravagant as it may appear at present, may yet prove to be true. Is the sun a magnet?

Summing up the situation in April, 1912, he repeated:

> The evidence (whether the sun is a magnet) rests entirely on the form of certain rays of the corona, which—assuming that they indicate the path of projecting particles—seem to be deflected as they would be in a magnetic field, but this evidence is not at all decisive.

There remained the possibility of an appeal to a conclusive test of magnetism; the characteristic changes it produces in light which originates in a magnetic field.

Before describing how this test has been applied, let us rapidly recapitulate some of the principal facts of terrestrial magnetism. You see upon the screen the image of a steel sphere (fig. 2), which has been strongly magnetized. If iron filings are sprinkled over the glass plate that supports it, each minute particle becomes a magnet under the influence of the sphere. When the plate is tapped, to relieve the friction, the particles fall into place along the lines of force, revealing a characteristic pattern of great beauty. A small compass needle, moved about the sphere, always turns so as to point along the lines of force. At the magnetic poles, it points toward the center of the sphere. Midway between them, at the equator, it is parallel to the diameter joining the poles.

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As the earth is a magnet, it should exhibit lines of force resembling those of the sphere. If the magnetic poles coincided with the poles of rotation, the north-seeking end of a freely suspended magnetic needle should point vertically downward at one pole and vertically upward at the other, and the needle should be horizontal at the equator. A dip needle, used to map the lines of force of the earth, is shown on the screen. I have chosen for illustration an instrument designed for use at sea on the nonmagnetic yacht *Carnegie* (fig. 3), partly because the equipment used by Dr. Bauer in his extensive surveys represents the best now in use, and also because I wish to contrast the widely different means employed by the Carnegie Institution for the investigation of solar and terrestrial magnetic phenomena. The support of the dip needle is hung in gimbals, so that observations may be taken when the ship's deck is inclined. The smallest possible amount of metal enters into the construction of this vessel, and where its use could not be avoided, bronze was employed instead of iron or steel. She is thus admirably adapted for magnetic work, as is shown by the observations secured on voyages already totaling more than 100,000 miles. Her work is supplemented by that of land parties, bearing instruments to remote regions where magnetic observations have never before been made.

The dip needle clearly shows that the earth is a magnet, for it behaves in nearly the same way as the little needle used in our experiment with the magnetized sphere. But the magnetic poles of the earth do not coincide with the geographical poles. The north magnetic pole, discovered by Ross and last visited by Amundsen in 1903, lies near Baffins Bay, in latitude 70° north, longitude 97° west. The position of the south magnetic pole, calculated from observations made in its vicinity by Capt. Scott, of glorious memory, in his expedition of 1901–1904, is 72° 50′ south latitude, 153° 45′ east longitude. Thus the two magnetic poles are not only displaced about 20° from the geographical poles, they do not even lie on the same diameter of the earth. Moreover, they are not fixed in position, but appear to be moving in paths near the geographical poles in a period not yet definitely known. In addition to these peculiarities, it must be added that the dip needle shows the existence of local magnetic poles, one of which has recently been found by Dr. Bauer at Treadwell Point, Alaska. At such a place the direction of the needle undergoes rapid change as it is moved about the local pole.

The dip needle, as we have seen, is free to move in a vertical plane. The compass needle moves in a horizontal plane. In general, it tends to point toward the magnetic pole, and as this does not correspond with the geographical pole there are not many places on the earth's surface where the needle indicates true north and south. Local peculiarities, such as deposits of iron ore, also affect its direction very

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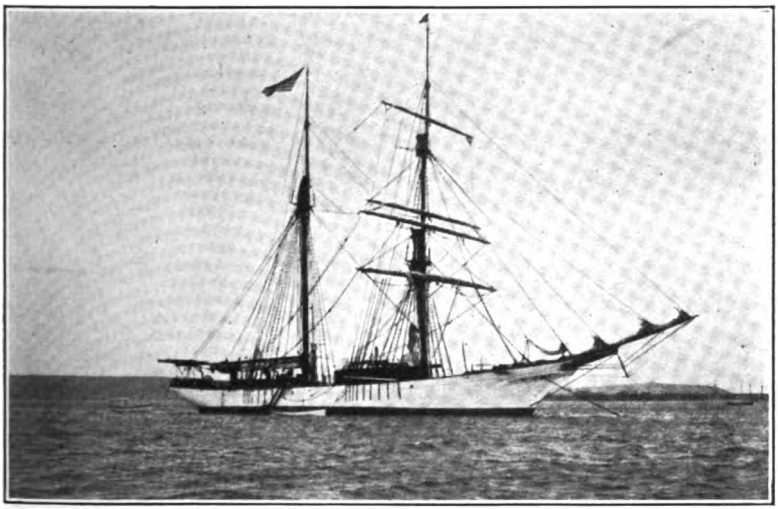

FIG. 3.—THE NONMAGNETIC YACHT CARNEGIE.

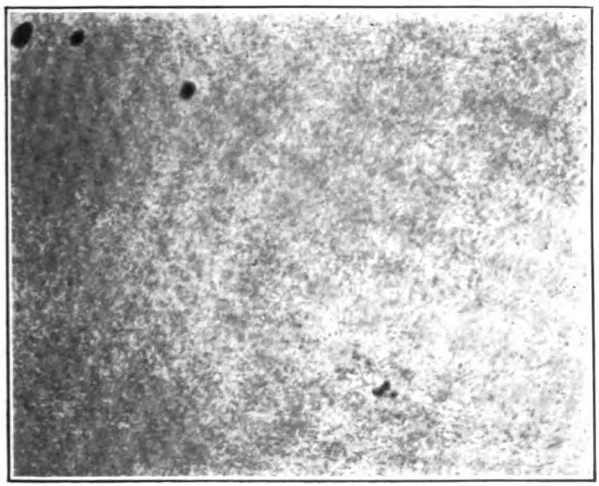

FIG. 4.—DIRECT PHOTOGRAPH OF PART OF THE SUN, APRIL 30, 1908.

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materially. Thus a variation chart, which indicates the deviation of the compass needle from geographical north, affords an excellent illustration of the irregularities of terrestrial magnetism. The necessity for frequent and accurate surveys of the earth's magnetic field is illustrated by the fact that the *Carnegie* has found errors of five or six degrees in the variation charts of the Pacific and Indian Oceans.

In view of the earth's heterogeneous structure, which is sufficiently illustrated by its topographical features, marked deviations from the uniform magnetic properties of a magnetized steel sphere are not at all surprising. The phenomenon of the secular variation is one of the peculiarities toward the solution of which both theory and experiment should be directed.

Passing over other remarkable phenomena of terrestrial magnetism, we come to magnetic storms and auroras, which are almost certainly of solar origin.

Here is a photograph of the sun as it appears in the telescope (fig. 4[1]). Scattered over its surface are sun spots, which increase and decrease in number in a period of about 11.3 years. It is well known that a curve showing the number of spots on the sun is closely similar to a curve representing the variations of intensity of the earth's magnetism. The time of maximum sun spots corresponds, as Dr. Bauer found, with that of reduced intensity of magnetization of the earth, and the parallelism of the two curves is too close to be the result of accident. We may therefore conclude that there is some connection between the spotted area of the sun and the magnetic field of the earth.

We shall consider a little later the nature of sun spots, but for the present we may regard them simply as solar storms. When spots are numerous the entire sun is disturbed, and eruptive phenomena, far transcending our most violent volcanic outbursts, are frequently visible. In the atmosphere of the sun gaseous prominences rise to great heights. This one (shown on the screen), reaching an elevation of 85,000 miles, is of the quiescent type, which changes gradually in form and is abundantly found at all phases of the sun's activity. But such eruptions as the one of March 25, 1895, photographed with the spectroheliograph of the Kenwood Observatory, are clearly of an explosive nature. As these photographs show, it shot upward through a distance of 146,000 miles in 24 minutes, after which it faded away.

When great and rapidly changing spots, usually accompanied by eruptive prominences, are observed on the sun, brilliant displays of the aurora (fig. 7) and violent magnetic storms are often reported. The magnetic needle, which would record a smooth straight line on the photographic film if it were at rest, trembles and vibrates, draw-

[1] Figs. 4, 5, and 6 represent the same region of the sun, photographed at successively higher levels.

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ing a broken and irregular curve. Simultaneously, the aurora flashes and pulsates, sometimes lighting up the sky with the most brilliant display of red and green discharges.

Birkeland and Störmer have worked out a theory which accounts in a very satisfactory way for these phenomena. They suppose that electrified particles, shot out from the sun with great velocity, are drawn in toward the earth's magnetic poles along the lines of force. Striking the rarefied gases of the upper atmosphere, they illuminate them, just as the electric discharge lights up a vacuum tube. There is reason to believe that the highest part of the earth's atmosphere consists of rarefied hydrogen, while nitrogen predominates at a lower level. Some of the electrons from the sun are absorbed in the hydrogen above a height of 60 miles. Others reach the lower-lying nitrogen and descend to levels from 30 to 40 miles above the earth's surface. Certain still more penetrating rays sometimes reach an altitude of 25 miles, the lowest hitherto found for the aurora. The passage through the atmosphere of the electrons which cause the aurora also gives rise to the irregular disturbances of the magnetic needle observed during magnetic storms.

The outflow of electrons from the sun never ceases, if we may reason from the fact that the night sky is at all times feebly illuminated by the characteristic light of the aurora. But when sun spots are numerous, the discharge of electrons is most violent, thus explaining the frequency of brilliant auroras and intense magnetic storms during sun-spot maxima. It should be remarked that the discharge of electrons does not necessarily occur from the spots themselves but rather from the eruptive regions surrounding them.

Our acquaintance with vacuum-tube discharges dates from an early period, but accurate knowledge of these phenomena may be said to begin with the work of Sir William Crookes in 1876. A glass tube, fitted with electrodes and filled with any gas, is exhausted with a suitable pump until the pressure within it is very low. When a high-voltage discharge is passed through the tube, a stream of negatively charged particles is shot out from the cathode or negative pole with great velocity. These electrons, bombarding the molecules of the gas within the tube, produce a brilliant illumination, the character of which depends upon the nature of the gas. The rare hydrogen gas in the upper atmosphere of the earth, when bombarded by electrons from the sun, glows like the hydrogen in this tube. Nitrogen, which is characteristic of a lower level, shines with the light which can be duplicated here.

But it may be remarked that this explanation of the aurora is only hypothetical in the absence of direct evidence of the emission of electrons by the sun. However, we do know that hot bodies emit electrons. Here is a carbon filament in an exhausted bulb. When

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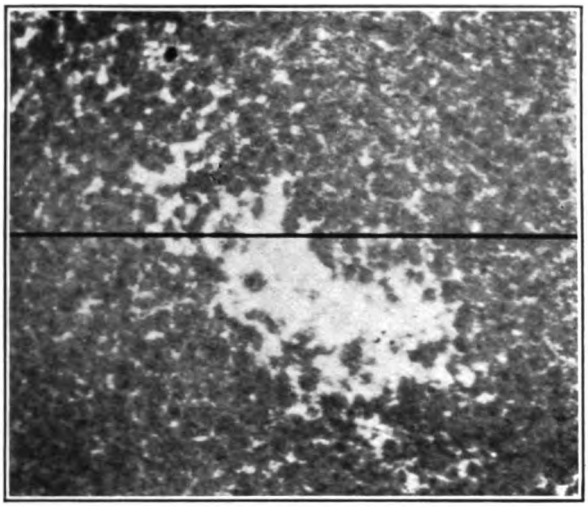

FIG. 5.—SAME REGION OF THE SUN, SHOWING THE CALCIUM (H_2) FLOCCULI.

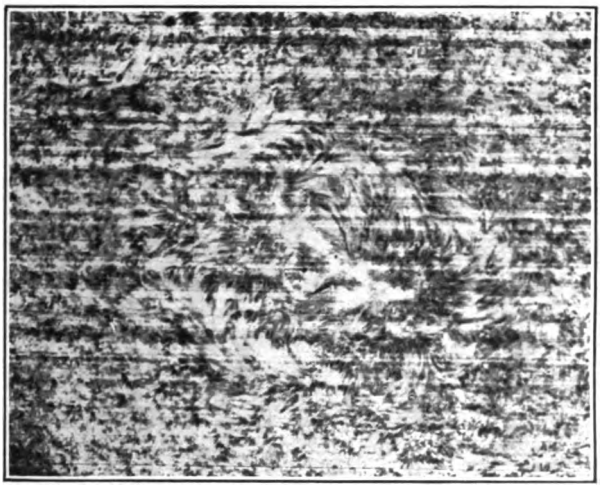

FIG. 6.—SAME REGION OF THE SUN, SHOWING THE HYDROGEN ($H\alpha$) FLOCCULI.

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heated white hot, a stream of electrons passes off. Falling upon this electrode, the electrons discharge the electroscope with which it is connected. Everyone who has to discard old incandescent lamps is familiar with the result of this outflow. The blackening of the bulbs is due to finely divided carbon carried away by the electrons and deposited upon the glass.

Now, we know that great quantities of carbon in a vaporous state exist in the sun and that many other substances, also present there, emit electrons in the same way. Hence we may infer that electrons are abundant in the solar atmosphere.

The temperature of the sun is between 6,000° and 7,000° C., twice as high as we can obtain by artificial means. Under solar conditions the velocity of the electrons emitted in regions where the pressure is not too great may be sufficient to carry them to the earth. Arrhenius holds that the electrons attach themselves to molecules or groups of molecules and are then driven to the earth by light pressure.

In certain regions of the sun we have strong evidence of the existence of free electrons. This leads us to the question of solar magnetism and suggests a comparison of the very different conditions in the sun and earth. Much alike in chemical composition, these bodies differ principally in size, in density, and in temperature. The diameter of the sun is more than 100 times that of the earth, while its density is only one-quarter as great. But the most striking point of difference is the high temperature of the sun, which is much more than sufficient to vaporize all known substances. This presumably means that no permanent magnetism, such as is exhibited by a steel magnet or a lodestone, can exist in the sun. For if we bring this steel magnet to a red heat, it loses its magnetism and drops the iron bar which it previously supported. Hence, while some theories attribute terrestrial magnetism to the presence within the earth of permanent magnets, no such theory is likely to apply to the sun. If magnetic phenomena are to be found there, they must result from other causes so far as we can judge from our present knowledge of magnetic phenomena at high temperatures.

The familiar case of the helix illustrates how a magnetic field is produced by an electric current flowing through a coil of wire. But according to the modern theory, an electric current is a stream of electrons. Thus a stream of electrons in the sun should give rise to a magnetic field. If the electrons were whirled in a powerful vortex resembling our tornadoes or waterspouts, the analogy with the wire helix would be exact, and the magnetic field might be sufficiently intense to be detected by spectroscopic observations.

A sun spot, as seen with a telescope or photographed in the ordinary way, does not appear to be a vortex. If we examine the solar atmosphere above and about the spots, we find extensive clouds of

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luminous calcium vapor, invisible to the eye, but easily photographed with the spectroheliograph, by admitting no light to the sensitive plate except that radiated by calcium vapor. These calcium flocculi (fig. 5), like the cumulus clouds of the earth's atmosphere, exhibit no well-defined linear structure. But if we photograph the sun with the red light of hydrogen, we find a very different condition of affairs (fig. 6). In this higher region of the solar atmosphere, first photographed on Mount Wilson in 1908, cyclonic whirls, centering in sun spots, are clearly shown.

The idea that sun spots may be solar tornadoes, which was strongly suggested by such photographs, soon received striking confirmation. A great cloud of hydrogen, which had hung for several days on the edge of one of these vortex structures, was suddenly swept into the spot at a velocity of about 60 miles per second. More recently Slocum has photographed at the Yerkes Observatory a prominence at the edge of the sun, flowing into a spot with a somewhat lower velocity.

Thus we were led to the hypothesis that sun spots are closely analogous to tornadoes or waterspouts in the earth's atmosphere (fig. 8). If this were true, electrons, caught and whirled in the spot vortex, should produce a magnetic field. Fortunately this could be put to a conclusive test through the well-known influence of magnetism on light discovered by Zeeman in 1896.

In Zeeman's experiment a flame containing sodium vapor was placed between the poles of a powerful electromagnet. The two yellow sodium lines, observed with a spectroscope of high dispersion, were seen to widen the instant a magnetic field was produced by passing a current through the coils of the magnet. It was subsequently found that most of the lines of the spectrum, which are single under ordinary conditions, are split into three components when the radiating source is in a sufficiently intense magnetic field. This is the case when the observation is made at right angles to the lines of force. When looking along the lines of force, the central line of such a triplet disappears (fig. 9), and the light of the two side components is found to be circularly polarized in opposite directions. With suitable polarizing apparatus, either component of such a line can be cut off at will, leaving the other unchanged. Furthermore, a double line having these characteristic properties can be produced only by a magnetic field. Thus it becomes a simple matter to detect a magnetic field at any distance by observing its effect on light emitted within the field. If a sun spot is an electric vortex, and the observer is supposed to look along the axis of the whirling vapor, which would correspond with the direction of the lines of force, he should find the spectrum lines double and be able to cut off either component with the polarizing attachment of his spectroscope.

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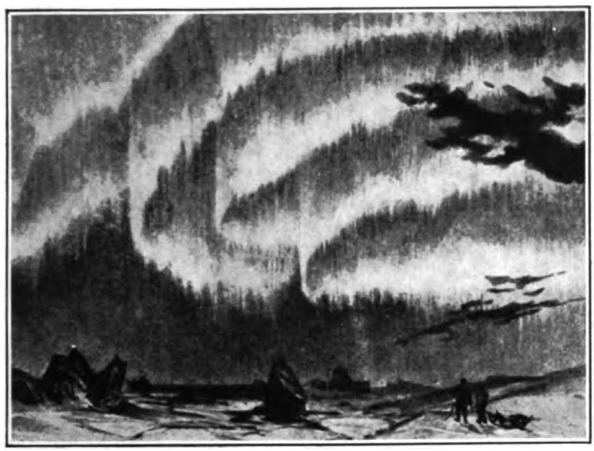

FIG. 7.—THE AURORA.

FIG. 8.—WATERSPOUT.

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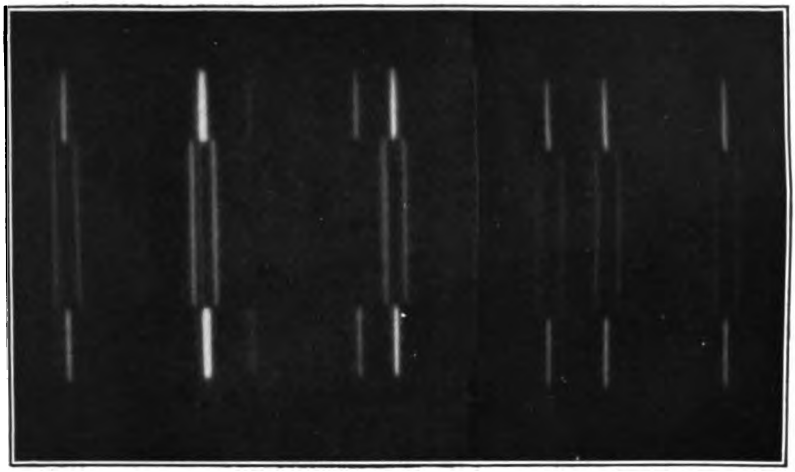

FIG. 9.—ZEEMAN DOUBLET PHOTOGRAPH IN LABORATORY SPECTRUM.

The middle section shows the doublet. The adjacent sections indicate the appearance of the spectrum line in the absence of a magnetic field.

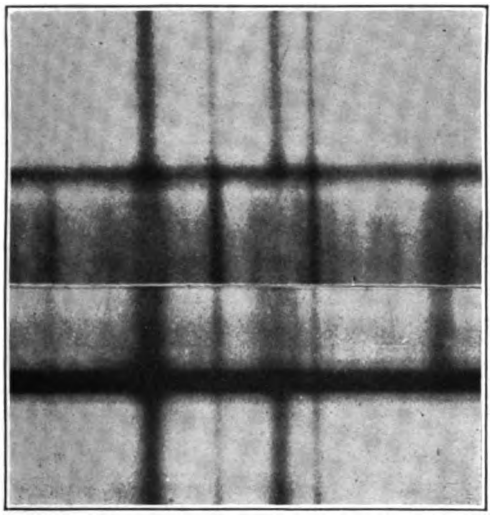

FIG. 10.—*a*, *b*, SPECTRA OF TWO SUN SPOTS.

The triple line indicates a magnetic field of 4,500 gausses in *a* and one of 2,900 gausses in *b*.

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I applied this test to sun spots on Mount Wilson in June, 1908, with the 60-foot tower telescope, and at once found all of the characteristic features of the Zeeman effect. Most of the lines of the sun spot spectrum are merely widened by the magnetic field, but others are split into separate components (fig. 10), which can be cut off at will by the observer. Moreover, the opportune formation of two large spots, which appeared on the spectroheliograph plates to be rotating in opposite directions (fig. 11), permitted a still more exacting experiment to be tried. In the laboratory, where the polarizing apparatus is so adjusted as to transmit one component of a line doubled by a magnetic field, this disappears and is replaced by the other component when the direction of the current is reversed. In other words, one component is visible alone when the observer looks toward the north pole of the magnet, while the other appears alone when he looks toward the south pole. If electrons of the same kind are rotating in opposite directions in two sun spot vortices, the observer should be looking toward a north pole in one spot and toward a south pole in the other. Hence the opposite components of a magnetic double line should appear in two such spots. As our photographs show, the result of the test was in harmony with my anticipation.

I may not pause to describe the later developments of this investigation, though two or three points must be mentioned. The intensity of the magnetic field in sun spots is sometimes as high as 4,500 gausses, or 9,000 times the intensity of the earth's field. In passing upward from the sun's surface, the magnetic intensity decreases very rapidly, so rapidly, in fact, as to suggest the existence of an opposing field. It is probable that the vortex which produces the observed field is not the one that appears on our photograph, but lies at a lower level. In fact, the vortex structure shown on spectroheliograph plates may represent the effect rather than the cause of the sun spot field. We may have, as Brester and Deslandres suggest, a condition analogous to that illustrated in the aurora—electrons, falling in the solar atmosphere, move along the lines of force of the magnetic field into spots. In this way we may perhaps account for the structure surrounding pairs of spots of opposite polarity which constitute the typical sun-spot group. The resemblance of the structure near these two bipolar groups to the lines of force about a bar magnet is very striking, especially when the disturbed condition of the solar atmosphere, which tends to mask the effect, is borne in mind. It is not unlikely that the bipolar group is due to a single vortex of the horseshoe type, such as we may see in water after every sweep of an oar.

We thus have abundant evidence of the existence on the sun of local magnetic fields of great intensity—fields so extensive that the

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earth is small in comparison with many of them. But how may we account for the copious supply of electrons needed to generate the powerful currents required in such enormous electromagnets? Neutral molecules, postulated in theories of the earth's field, probably will not suffice. A marked preponderance of electrons of one sign seems to be indicated.

An interesting experiment, due to Harker, will help us here. Imagine a pair of carbon rods insulated within a furnace heated to a temperature of two or three thousand degrees. The outer ends of the rods, projecting from the furnace are connected to a galvanometer. Harker found that when one of the carbon terminals within the furnace was cooler than the other a stream of negative electrons flowed toward it from the hotter electrode. Even at atmospheric pressure currents of several amperes were produced in this way.[1]

Our spectroscopic investigations, interpreted by laboratory experiments, are in harmony with those of Fowler in proving that sun spots are comparatively cool regions in the solar atmosphere. They are hot enough, it is true, to volatilize such refractory elements as titanium, but cool enough to permit the formation of certain compounds not found elsewhere in the sun. Hence, from Harker's experiment, we may expect a flow of negative electrons toward spots. These, caught and whirled in the vortex, would easily account for the observed magnetic fields.

The conditions existing in sun spots are thus without any close parallel among the natural phenomena of the earth. The sun-spot vortex is not unlike a terrestrial tornado on a vast scale, but if the whirl of ions in a tornado produces a magnetic field it is too feeble to be readily detected. Thus, while we have demonstrated the existence of solar magnetism it is confined to limited areas. We must look further if we would throw new light on the theory of the magnetic properties of rotating bodies.

This leads us to the question with which we started: Is the sun a magnet like the earth? The structure of the corona, as revealed at total eclipses, points strongly in this direction. Remembering the lines of force of our magnetized steel sphere, we can not fail to be struck by their close resemblance to the polar streamers in these beautiful photographs of the corona (fig. 12) taken by Lick Observatory eclipse parties, for which I am indebted to Prof. Campbell. Bigelow, in 1889, investigated this coronal structure and showed that it is very similar to the lines of force of a spherical magnet. Störmer, guided by his own researches on the aurora, has calculated the trajectories of electrons moving out from the sun under the influence of a general magnetic field, and compared these trajectories with the

[1] King has recently found that the current decreases very rapidly as the pressure increases, but is still appreciable at a pressure of 20 atmospheres.

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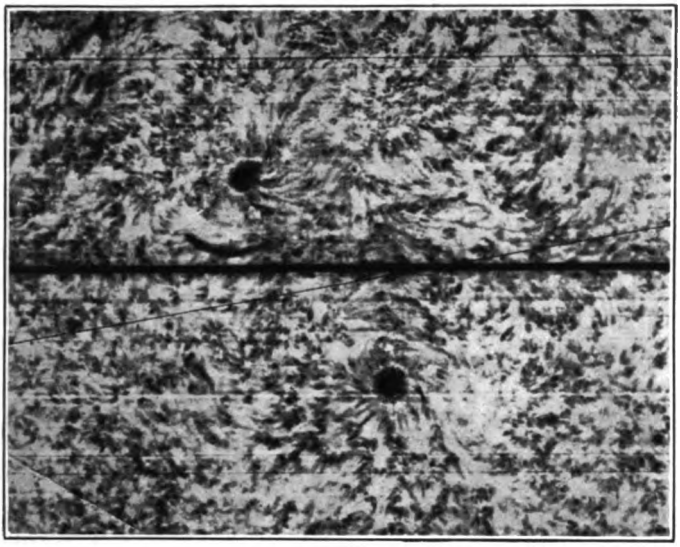

FIG. 11.—RIGHT AND LEFT HANDED VORTICES SURROUNDING SUN SPOTS, AS INDICATED BY THE DISTRIBUTION OF HYDROGEN GAS.

Photographed with the spectroheliograph.

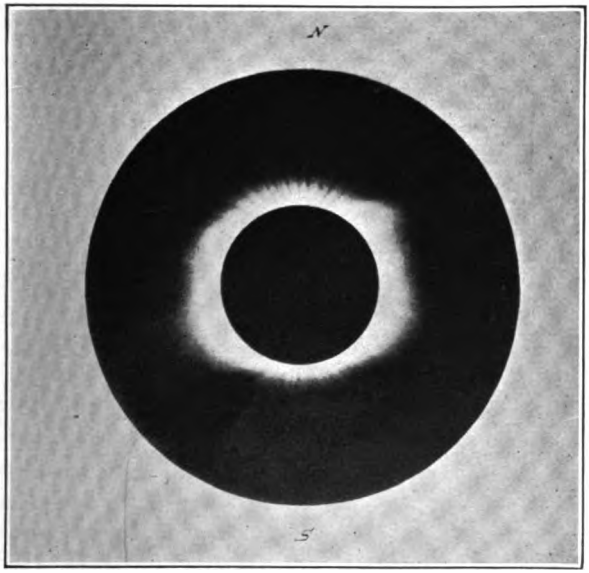

FIG. 12.—SOLAR CORONA, SHOWING POLAR STREAMERS.

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coronal streamers.[1] The resemblance is apparently too close to be the result of chance. Finally, Deslandres has investigated the forms and motions of solar prominences, which he finds to behave as they would in a magnetic field of intensity about one millionth that of the earth. We may thus infer the existence of a general solar magnetic field. But since the sign of the charge of the outflowing electrons is not certainly known, we can not determine the polarity of the sun in this way. Furthermore, our present uncertainty as to the proportion at different levels of positive and negative electrons, and of the perturbations due to currents in the solar atmosphere, must delay the most effective application of these methods, though they promise much future knowledge of the magnetic field at high levels in the solar atmosphere.

Of the field at low levels, however, they may tell us little or nothing. To detect this low-level field we must resort to the method employed in the case of sun spots—the study of the Zeeman effect. If this is successful, it will not only show beyond doubt whether the sun is a magnet—it will also permit the polarity of the sun to be compared with that of the earth, give a measure of the strength of the field at different latitudes, and indicate the sign of the charge that a rotating sphere must possess if it is to produce a similar field.

I first endeavored to apply this test with the 60-foot tower telescope in 1908, but the results were too uncertain to command confidence.

Thanks to additional appropriations from the Carnegie Institution of Washington, a new and powerful instrument was available on Mount Wilson for a continuation of the investigation in January, 1912. The new tower telescope has a focal length of 150 feet (fig. 13). To prevent vibration in the wind, the cœlostat, second mirror, and object glass are carried by a skeleton tower, each vertical and diagonal member of which is inclosed within the corresponding member of an outer skeleton tower, which also carries a dome to shield the instruments from the weather. In the photograph we see only the hollow members of the outer tower, but within each of them, well separated from possible contact, a sectional view would show the similar but more slender members of the tower that support the instruments. The plan has proved to be successful, permitting observations demanding the greatest steadiness of the solar image to be made.

The arrangements are similar to those of the 60-foot tower. The solar image, 16½ inches in diameter, falls on the slit of a spectrograph (fig. 14) in the observation house at the ground level. The spectrograph, of 75 feet focal length, enjoys the advantage of great stability and constancy of temperature in its subterranean vault beneath the

[1] See also the important investigations of Birkeland.

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tower. In the third-order spectrum, used for this investigation, the D lines of the solar spectrum are 29 millimeters apart. The resolving power of the excellent Michelson grating is sufficient to show 75 lines of the iodine absorption spectrum in this space between the D's. Thus the instruments are well suited for the exacting requirements of a difficult investigation. For it must be borne in mind that the problem is very different from that of detecting the magnetic fields in sun spots, where the separation of the lines is from 50 to 100 times as great as we may expect to find here. Thus the sun's general field can produce no actual separation of the lines. But it may cause a very slight widening, which should appear as a displacement when suitable polarizing apparatus is used. This is so arranged as to divide the spectrum longitudinally into narrow strips. The component toward the red end of the spectrum of a line widened by magnetism should appear in one strip, the other component in the next strip. Hence, if the sun has a magnetic field of sufficient strength the line should have a dentated appearance. The small relative displacements of the lines on successive strips, when measured under a microscope, should give the strength of the magnetic field.

The above remarks apply strictly to the case when the observer is looking directly along the lines of force. At other angles neither component is completely cut off, and the magnitude of the displacement will then depend upon two things—the strength of the magnetic field and the angle between the line of sight and the lines of force. Assuming that the lines of force of the sun correspond with those of a magnetized sphere, and also that the magnetic poles coincide with the poles of rotation, it is possible to calculate what the relative displacement should be at different solar latitudes. These theoretical displacements are shown graphically by the sine curve on the screen (fig. 15).

We see from the curve that the greatest displacements should be found at 45° north and south latitude, and that from these points they should decrease toward zero at the equator and the poles. Furthermore, the curve shows that we may apply the same crucial test used in the case of sun spots; the direction of the displacements, toward red or violet, should be reversed in the northern and southern hemispheres.

I shall not trouble you with the details of the hundreds of photographs and the thousands of measures which have been made by my colleagues and myself during the past year. In view of the diffuse character of the solar lines under such high dispersion, and the exceedingly small displacements observed, the results must be given with some reserve, though they appear to leave no doubt as to the reality of the effect. Observations in the second order spectrum failed to give satisfactory indications of the field. But with the higher

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FIG. 13.—150-FOOT TOWER TELESCOPE.

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dispersion of the third order, 11 independent determinations, made with every possible precaution to eliminate bias, show opposite displacements in the northern and southern hemispheres, decreasing in magnitude from about 45° north and south latitude to the equator. Three of these determinations were pushed as close to the poles as conditions would permit, and the observed displacements may be compared with the theoretical curve (fig. 15). In view of the very small magnitude of the displacements, which never surpass 0.002 Angstrōms, the agreement is quite as satisfactory as one could expect for a first approximation.

The full details of the investigation are given in a paper recently published.[1] The reader will find an account of the precautions taken to eliminate error and, I trust, no tendency to underestimate the possible adverse bearing of certain negative results. It must remain for the future to confirm or to overthrow the apparently strong evidence in favor of the existence of a true Zeeman effect, due to the general magnetic field of the sun. If this evidence can be accepted, we may draw certain conclusions of present interest.

Taking the measures at their face value, they indicate that the north magnetic pole of the sun lies at or near the north pole of rotation, while the south magnetic pole lies at or near the south pole of rotation. In other words, if a compass needle could withstand the solar temperature, it would point approximately as it does on the earth, since the polarity of the two bodies appears to be the same. Thus, since the earth and sun rotate in the same direction, the preponderant influence of a negative charge distributed through their mass (in combination with an equal positive charge of slightly different volume density) would account in each case for the observed magnetic polarity.

As for the strength of the sun's field, only three preliminary determinations have yet been made, with as many different lines. Disregarding the systematic error of measurement, which is still very uncertain, these indicate that the field-strength at the sun's poles is of the order of 50 gausses (about 80 times that of the earth).

Schuster, assuming the magnetic fields of the earth and sun to be due to their rotation, found that the strength of the sun's field should be 440 times that of the earth, or 264 gausses.[2] This was on the supposition that the field-strength of a rotating body is proportional to the product of the radius and the maximum linear velocity of rotation, but neglected the density. Before inquiring why the observed and theoretical values differ, we may glance at the two most promising hypotheses that have been advanced in support of the view that every large rotating body is a magnet.

[1] Contributions from the Mount Wilson Solar Observatory, No. 71.

[2] Bauer, by a similar method, obtained 306 gausses.

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On account of their greater mass, the positive electrons of the neutral molecules within the earth may perhaps be more powerfully attracted by gravitation than the negative electrons. In this case the negative charge of each molecule should be a little farther from the center of the earth than the positive charge. The average linear velocity of the negative charge would thus be a little greater, and the magnetizing effect due to its motion would slightly exceed that due to the motion of the positive charge. By assuming a separation of the charges equal to about four-tenths the radius of a molecule (Bauer) the symmetrical part of the earth's magnetic field could be accounted for as the result of the axial rotation.[1]

This theory, first suggested by Thomson, has been developed by Sutherland, Schuster, and Bauer. But as yet it has yielded no explanation of the secular variation of the earth's magnetism, and other important objections have been urged against it. While it should not be rejected, the merits of other theories must not be overlooked.

Chief among these is the theory that rests on the very probable assumption that every molecule is a magnet. If the magnetism is accounted for as the effect of the rapid revolution of electrons within the molecule, a gyrostatic action might be anticipated. That is, each molecule would tend to set itself with its axis parallel to the axis of the earth, just as the gyrostatic compass, now coming into use at sea, tends to point to the geographical pole. The host of molecular magnets, all acting together, might account for the earth's magnetic field.

This theory, in its turn, is not free from some points of weakness, though they may disappear as the result of more extended investigation. Its chief advantage lies in the possibility that it may perhaps explain the secular variation of the earth's magnetism by a precessional motion of the magnetic molecules.

On either hypothesis, it is assumed, in the absence of knowledge to the contrary, that every molecule contributes to the production of the magnetic field. Thus the density of the rotating body may prove to be a factor. Perhaps the change of density from the surface to the center of the sun must also be taken into account. But the observational results already obtained suggest that the phenomena of ionization in the solar atmosphere may turn out to be the predominant influence.

The lines which show the Zeeman effect originate at a comparatively low level in the solar atmosphere. Preliminary measures

[1] According to Bauer's view, in each molecule one charge occupies a larger volume than the other, so as to make the volume densities of the two charges at the same point slightly different.

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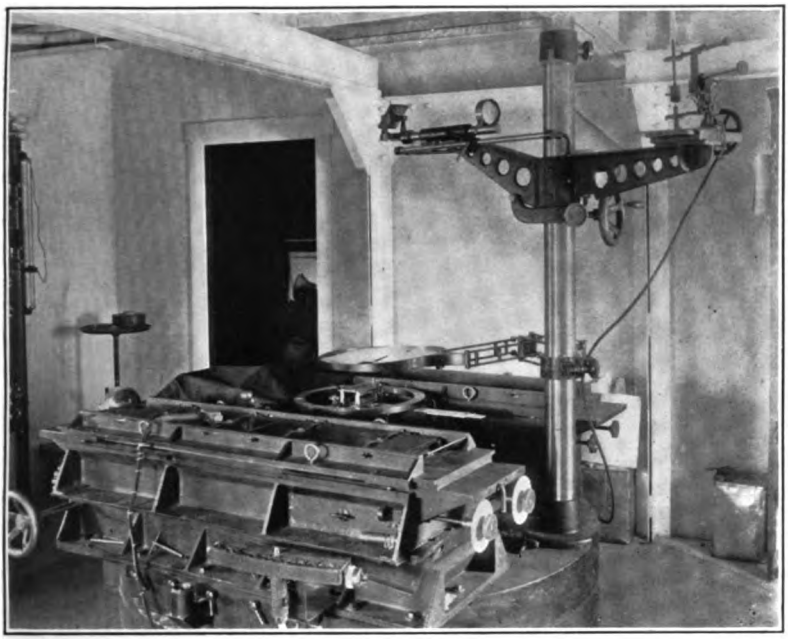

FIG. 14.—HEAD OF THE 75-FOOT SPECTROGRAPH OF THE 150-FOOT TOWER TELESCOPE.

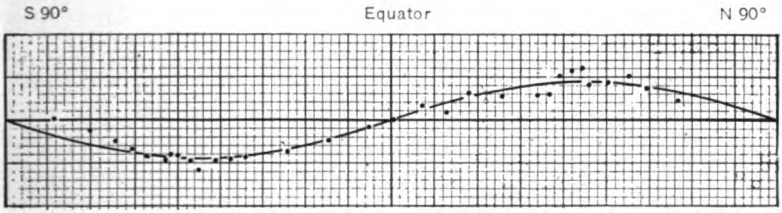

FIG. 15.—THE CURVE REPRESENTS THE THEORETICAL VARIATION OF THE DISPLACEMENTS OF SPECTRUM LINES WITH THE HELIOGRAPHIC LATITUDE. THE SUN IS ASSUMED TO BE A MAGNETIZED SPHERE WITH ITS MAGNETIC POLES COINCIDING WITH THE POLES OF ROTATION. THE POINTS REPRESENT MEAN VALUES OF THE OBSERVED DISPLACEMENTS. VERTICAL SCALE: 1 SQUARE = 0.001 MM. = 0.0002 ANGSTRÖM.

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indicate that certain lines of titanium, which are widely separated by a magic field in the laboratory, are not appreciably affected in the sun. As these lines represent a somewhat higher level, it is probable that the strength of the sun's field decreases very rapidly in passing upward from the surface of the photosphere—a conclusion in harmony with results obtained from the study of the corona and prominences. Thus it may be found that the distribution of the electrons is such as to give rise to the observed field or to produce a field opposing that caused by the rotation of the body of the sun. It is evident that speculation along these lines may advantageously await the accumulation of observations covering a wide range of level. Beneath the photosphere, where the pressure is high, we may conclude from recent electric furnace experiments by King that free electrons, though relatively few, may nevertheless play some part in the production of the general magnetic field.

In this survey of magnetic phenomena, we have kept constantly in mind the hypothesis that the magnetism of the earth is due to its rotation. Permanent magnets, formerly supposed to account for the earth's magnetic field, probably can not exist at the high temperature of the sun. Displays of the aurora, usually accompanied by magnetic storms, are plausibly attributed to electrons reaching the earth from the sun, and illuminating the rare gases of the upper atmosphere just as they affect those in a vacuum tube. Definite proof of the existence of free electrons in the sun is afforded by the discovery of powerful local magnetic fields in sun spots, where the intensity of the field is sometimes as great as nine thousand times that of the average value of the earth's field. These local fields probably result from the rapid revolution in a vortex of negative electrons, flowing toward the cooler spot from the hotter region outside. The same method of observation now indicates that the whole sun is a magnet, of the same polarity as the earth. Because of the high solar temperature, this magnetism may be ascribed to the sun's axial rotation.[1] It is not improbable that the earth's magnetism also results from its rotation, and that other rotating celestial bodies, such as stars and nebulæ, may ultimately be found to possess magnetic properties. Thus, while the presence of free electrons in the sun prevents our acceptance of the evidence as a proof that every large rotating body is a magnet, the results of the investigation are not opposed to this hypothesis, which may be tested further by the study of other stars of known diameter and velocity of rotation.

[1] The alternative hypothesis, that the sun's magnetism is due to the combined effect of numberless local magnetic fields, caused by electric vortices in the solar "pores," though at first sight improbable, deserves further consideration.

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ADDRESS OF DR. J. C. KAPTEYN, DIRECTOR OF THE ASTRONOMICAL LABORATORY UNIVERSITY OF GRONINGEN, ON "THE STRUCTURE OF THE UNIVERSE."

I have been asked to address you on the structure of the universe. The title is ambitious, and I fear that what I have to say on the subject will be sadly in disproportion with what some of you will be led to expect by this title.

It will, however, I hope, give you a glimpse of what astronomers nowadays are attempting to do, in order to penetrate somewhat into the mystery of the starry sky.

The problem, as I take it, is a double one. We have, first, the structure of the universe as it is at the present moment; and this problem is, in the main, no other than finding the star distances, because the star directions we can readily ascertain.

We have, second, the problem of the history and evolution of the system.

As the time at my disposal is so short, I must confine myself to one of the two, and undoubtedly the first is at the present moment the more promising, owing to the recent discovery of star streaming, and due furthermore to the history of the system during the past ages, ages to be counted by millions and probably hundreds of millions of years, which is and perhaps will remain enshrouded in great mystery. Still I think that the second problem of the evolution of the system may, perhaps, be the more suitable subject for the present lecture.

You will all, of course, understand, without my saying anything to the purpose, that what we have to expect can not well be anything else than a few more or less probable inferences about the course of events that have made our system what it is.

Some additional considerations might easily have been added, but as I have had to give up the idea of giving a general review of what has been done, I thought it might be as well to confine myself to just a few illustrations of the kind of speculations that we are at present being led to; and as these speculations, mainly or wholly, also depend on the theory of star streaming, it may be well to begin by saying a few words about that theory.

In order to get a clear idea of what is understood by the phenomenon of star streaming: Imagine two clouds or swarms of stars, at first wide apart in space; imagine that the stars within each cloud move in all directions, indiscriminately, pretty much as do the molecules of gas, and let us call this motion in the cloud the "internal motion." In fact, imagine two immense gas bubbles, the molecules of which will be our stars.

Now, imagine these two clouds to be moving in space, and let that motion bring the two gas bubbles together, so that they will penetrate each other. Then imagine that we, the spectators, are in

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that part of the universe where the two bubbles have intermixed, and finally imagine that we, the spectators, have a motion of our own.

What we will see of the motion of the individual gas molecules will very nearly correspond to what we see of the motion of the stars actually going on in the sky.

Now, how does this motion show? Had the molecules in each gas bubble no internal motion; that is, had they no other motion than the common motion of all the molecules together as a whole gas bubble, then of course what you would see would be this: We would see two immense streams of stars, all moving in perfectly parallel lines, with perfectly equal velocity. If, however, the internal motion is not zero, then of course what we will see will be more or less different. The internal motion gives to each molecule, in addition to the motion which is common to the whole of the bubble, an additional individual motion, which will be the cause of the total motion of the several molecules that are not perfectly parallel or perfectly equal; and instead of seeing two perfect streams with perfectly parallel motions, we must now see the stars in the main parallel to two great directions; but there will be deviations—small deviations will be frequent, greater deviations will be rare, and very great deviations will be decidedly exceptional. The motions of the two individual bubbles will still be clearly discernible.

So it is with the stars in the sky we have recognized two clearly defined preferential motions. These directions make an angle of about 100°. The stars are not moving in these directions only. Small deviations are frequent; greater deviations are somewhat rare; very great deviations are decidedly exceptional. This describes what is actually observed in the sky.

We may say that all investigations made since the first announcement of star-streaming in 1904—investigations based on very different materials—all agree in the establishment of these two preferential directions of motion among the stars. We find them in the brightest stars; we find them in the fainter stars; they show in the swift-moving stars; they show in the slow-moving stars. They betray their existence not only in the radial motions but as well in the motion at right angles to the visible ray.

Our conception of two independent star clouds is one of these investigations. Whether this interpretation is the correct one, is a question of evolution of the system and will have to be considered presently. Our conclusion will eventually be in favor of the two-cloud theory; and so, for the sake of greater clearness, I will continue to use this conception.

In the study of the history of the system, we start from what we know, or think we know, about the evolution of the separate stars.

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The stars have been classified by Secchi into four spectral classes. We have a far more elaborate classification, but for the present purpose Secchi's classification will do. The stars of the fourth type are so few in number that we may, for the present, neglect them.

On the other hand, there is a class of stars showing the helium lines, that formerly was classified with all the other classified stars, but is now considered as a separate class—the helium stars.

So that now, neglecting the stars of Secchi's fourth type, we have still four types, which will be the helium stars, and the first, second, and third types of stars—helium, first. second, and third. Now, there is much evidence to show that this classification in this order is a natural one. I mean that the order is really an order of evolution, the helium stars being the stars of recent birth; while we get to the older and older stars as we pass from the helium stars to the first, from the first to the second, and from the second to the third. I will adopt this classification in what follows, although well aware of the fact that all astronomers do not agree with me. I feel justified in this course, not only because I think it is the opinion of the great majortiy of our eminent spectroscopists, but also because the very facts which I wish to put before you about star-streaming strongly confirm it.

When we wish to penetrate into the history of the system it seems natural to investigate the problem of star-streaming separately for these four classes of stars in the order of their evolution. There are some difficulties, mainly the consequence of the scantiness of materials. Still, however, even now it has been possible to carry that investigation through in such a way as to establish a few facts, and to give clear indications of other facts. Of these I will consider only the two following, about the reality of which I think there can be left hardly any doubt.

First, the older the stars, the greater the internal velocity, and second, the older stars, the richer the second stream, at least in comparison with the first stream. And I wish to consider some of the inferences to which these facts lead us. In the first place, the facts at once lead us back to the question just now mentioned, about the order of evolution of the individual stars. For this regularity in the increase in the internal velocity and also in the richness of the second stream exists only if we arrange the stars in their order, helium, first, second, and third, or (of course I need not say so) in the reverse order, third, second, first, helium; but in no other arrangement.

Therefore, with the same right that we expect that all the properties of the stars will change with age, gradually, and not per saltum, with that same right, I think, we conclude that the order of evolution must be helium, first, second, third, or the exact reverse.

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Now, then, there is much evidence that it is not the reverse order; but I think it is better not to lose time in going into that point just now; and, therefore, I will say that we have strong confirmation here of what, on two or three different grounds, is pretty generally considered as the order of the different ages in a star's life.

But to proceed: As the younger the stars, the smaller their internal motion, it follows at once that if we go to a stage younger still, if we go back to that matter from which the helium stars have been evolved (and I call that matter primordial matter), that internal motion of primordial matter must be smaller still.

And, according to our second fact, the richness of the second stream is smaller and smaller, the younger the class of stars we consider.

The number of the helium stars is already so great that, not long ago, it was assumed that there was no trace of a second stream in the helium stars at all. We conclude, that in this still younger stage of evolution it is practically certain that there can not be a second stream at all.

Therefore, finally, we must expect that the particles of primordial matter will all move in practically parallel lines, in the direction and with the velocity of that stream in which all but the totality of the helium stars move.

It is a very general notion that that primordial matter, that matter from which the stars are evolved, is the matter of the nebulae. What precedes gives us the means of testing this theory by observation.

What, then, does observation show about the nebulæ? The number of available data is as yet extremely small. The determination of what we call astronomical proper motion of these very ill-defined nebulæ is extremely difficult, and has been up to the present time invariably unsuccessful. We can say that we know nothing about the astronomical motion of the nebulæ. To the determination of the radial velocity with the spectroscope the faintness of the object is a great obstacle. The consequence is that, as yet, we know the radial velocity of only fourteen of these objects in all. Still, this limited number is decisive in showing that there can be no question that the real motions of these objects are not even approximately parallel to the motion of the helium stars, or even parallel to any fixed direction whatever. Their velocity, moreover, is exceedingly unequal. Therefore, must we conclude that the nebulæ are not the birthplace of the stars? It may seem so.

Meanwhile let us not go too far. There are nebulæ and nebulæ, and it so happens—and there is ample practical reason for it—that with one exception observation of radial velocity has, up to the present time, been confined to what we call the planetary nebulæ—nebulæ elliptical or round, which show an appearance remotely like

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that of a planetary disk. Herschel saw in them a likeness to what, according to Laplace's cosmogony, must have been the primitive stage of our own planetary system; and therefore he though that these planetary nebulæ must be the birthplace of the stars.

Now, then, according to what precedes, this view seems now untenable. If they were, they would have shown the parallel and equal motion of practically all the helium stars. The motions on the contrary, are extremely unparallel, and unequal, and we must assign these objects a place at the end of the order of evolution rather than at the beginning.

We may, perhaps, see an independent confirmation of this view in the stars called temporary stars, but time will not permit me to pursue that argument further.

Meanwhile, as I said just now, there is one exception in which the radial velocity of the nebulæ has been determined, which is not planetary. This exception is the Orion nebula, the well-known Orion nebula, which is classified under the irregular nebulæ. Therefore, we might ask if its position with the irregular nebulæ was the birthplace of the stars.

It turns out that this one object has exactly the radial velocity of the helium stars in the first stream; that is, we find exactly the motion we must expect in these nebulæ if it were the birthplace of the stars. We will not, of course, on this single fact find far-reaching conclusions; but we have a right, in my opinion, to say that here is a fact that singularly strengthens what has already been concluded from other facts.

We see, moreover, that the observation of the radial velocity of other irregular nebulæ must ere long furnish us with a crucial test of the theory.

There is another problem involved in our observations which might seem to be of no less importance than the one just mentioned. How have we to explain the fact that the internal velocity of the stars gradually increases with age? The astronomer who, in the study of the motion of the heavenly bodies, has found hardly a trace of any other force than gravitation will naturally turn to gravitation for such an explanation; and it really seems a necessity that under the influence of the mutual gravitation bodies which at the outset have little or no relative motion must get such motion and they must come to fall toward each other and this velocity must increase with time.

Thus far there is no great difficulty; but now let us look farther back in time, back to the time in which the stars had not yet been formed and in which matter was still in its primordial state. If it be true that mutual attraction of the stars has generated such an enormous amount of internal motion in the time needed by the

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helium stars to develop from the helium stars to second and third class stars, how have we to explain that we find that same matter nearly at rest at the first stage of evolution at which we meet it? How have we to explain that in prehelium ages gravitation has produced no effect?

He that believes in the creation of matter at a finitely remote epoch may find no difficulty in the question; but to him who does not it is simply astonishing to see matter behaving as if there were no gravitation at all. What may be the explanation? Is there no gravitation in primordial matter, or is there another force exactly counterbalancing its effects?

I shall offer no solution. I simply wish to point out that here is a problem which may be interesting to the physicist no less than to the astronomer.

Passing to other inferences, I wish to draw your attention to a question already alluded to. Does the observed fact of the preference of the star motions for two definite directions lead us with necessity to the assumption that our system has been formed by the meeting of two independent star clouds? Or is it still possible, and in that case more plausible, to explain it without the sacrifice of the unity of the system? In other words, is it a dual system or is it one unit?

Suppose a very elongated system of stars which are originally at rest. Now, let these be left to their mutual attraction; then it is evident that those stars, under the influence of that gravitation, will fall together. The stars at the extreme ends of this elongated system will fall toward each other in a motion that will follow, in the main, the axis of that system of stars.

In the main there will be deviations, because, of course, the system is pretty long in comparison to its breadth; but still it is not linear. In other words, there will be set up two streams of stars in which all the stars will be moving preferentially, and there will be deviations. Those star-streams will be exactly opposite each other. There is no difficulty in that. True it is that the streams of stars we see make an angle of about 100 degrees; but it is evident that if we have two streams moving in exactly opposite directions and we view these streams from the earth, which itself has a motion in space, the consequence will then be that those opposite streams will be seen to make an angle; and it is easy to determine the earth's motion in such a way as to bring it in perfect harmony with the observation. Thus far there is no objection. It might seem that this evolution of the system, which saves the unity of the system, might explain the matter; but there are further consequences.

In an elongated universe as here supposed both the longitudinal motion (what we in this lecture have called the stream motion) and

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the deviations therefrom (what in this lecture have been called the internal motions) must gradually increase from zero to the value we find them having at the present time.

Now as to the internal velocities, this is exactly what we find by observation. Do we find the same for the stream motion?

Recent Mount Wilson observations have enabled us to derive at least a pretty reliable value of the relative stream velocities for the first type stars. For the helium stars we can as yet only assign a limit which the relative velocities of the two streams must exceed; but for the older stars we have had reliable information for some time.

All these determinations show, contrary to what takes place with the internal motion, that the relative velocity of the stream motion does not change, or does not change very much, at least, with age; certainly the stream motion is not nearly vanishing for the helium stars. It seems to me that this consideration is fatal to the present explanation.

Prof. Schwarzschild has developed a different theory, which also leaves the universe a unit; but this theory also can not, I think, be maintained. Among other things, we have, as a main objection, the fact—which was not known at the time Prof. Schwarzschild proposed his theory—that the richness of the two streams is not the same for stars of different age.

The tacit assumption is made, and must be made, under Schwarzschild's theory that the two streams have the same number of stars. Now, this may be more or less approximately true of the stars of the second and third types. It certainly is not true of stars of the first type.

While it is true that the first stream is three times richer than the second stream, the richness of the helium stars is certainly not a tenth of that of the first stream.

The conclusion to be drawn from all of this seems pretty obvious. It would seem that we are driven to the theory assumed here, from the first, the theory of the two star-clouds, which, owing to their initial velocity, have come to meet and intermingle in space.

It must be confessed, however, that in this theory also there remain some hard nuts to crack; and until we succeed in this it seems unsafe to claim any great certainty for the theory, and it seems preferable to put it forward as one hypothesis, which, for the time being, best fits the observed facts.

There remains to be considered the question how to explain that the second stream or cloud hardly contains any helium stars. There is something in the small local groups which we know in this type which may help us. Everybody knows the group of the Pleiades.

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There can be no doubt but that the bright stars and many of the faint stars that we see in this part of the sky are near together in space and not merely near together in the same visual line—the one far behind the other. They undoubtedly form a physical system, and must have had a common origin. At present we know several of such local groups, among them the Hyades, the Ursa Major group, and we may perhaps add the great Scorpius Centaur group.

Now, in these local groups, we find, amongst others, two very remarkable facts. The first is that if the stars of such groups are arranged in the order of their brightness, we find that they are arranged with a few, and it must be confessed, significant exceptions, in the order of the spectral classes. As an instance, take the Scorpius Centaur group. We find that the very brightest stars are of the earliest helium type; the somewhat fainter ones are of the next helium type; the next fainter ones are of the next stage in the stellar life, or the first type; and if we can not follow the series further on to the second and perhaps the third type, this is probably due to our ignorance about it or lack of knowledge of the fainter stars belonging to the group.

In the Pleiades, where we have a somewhat more extensive knowledge of the fainter stars, we can follow the series at least as far as the middle of the second type stars. It follows from this that in all these groups, what there are of helium stars can not be overlooked, for they all are of the very brightest stars, and our knowledge of the brightest stars is pretty complete.

Notwithstanding this—and this is the second remarkable fact, the fact that bears directly on the question in hand—we find not a single helium star, neither in the Hyades nor in the Ursa Major group. The stars in this group show a gradual change of spectrum with the brightness, but they certainly begin with the second stage of the star's life. In the Pleiades, this is somewhat different. Here there are some helium stars. But they begin abruptly with the middle stage of helium stars. There is not a single star of the early helium type in the Pleiades. So that the series begins, not at the beginning, but at some different point in the evolution.

As to our second stream, then, we have to explain that there is no second stream, or no appreciable number of helium stars in the second stream. Our second stream, then, in which we meet with no helium stars, is absolutely in the same condition as the group of the Hyades and the Ursa Major group; and the explanation of the two cases must, in all likelihood, be the same.

How, therefore, does it come to pass that in such groups as those of the Hyades and the Ursa Major the helium stars are absolutely wanting?

For those who, as I did in this lecture, adopt the view of the order of evolution as helium, first, second, third, there can be no question

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but that the stars which we now see are first-type stars, which must in past ages have been helium stars.

Therefore, such a group as the Hyades, which nowadays does not contain any helium stars, but which contains first-type stars, must in past ages have contained the helium stars in great numbers; and going back to times somewhat farther still, these helium stars must have been evolved from some primordial matter. This primordial matter is possibly some nebulous matter, and therefore, in the still earlier ages, these groups of the Hyades and Ursa Major must have been filled with nebulæ.

Now, then, in the present day, so far as we know, there is no trace of nebulæ in these groups. Our conclusion, therefore, is that there must have been some time in which the nebula in those groups was exhausted. It was probably taken up in the formation of stars. Since the exhaustion of the nebulous matter evidently there could be formed no more helium stars; and the helium stars that had been formed developed gradually in the second stage into first-type stars, and in a short time there will be an end to helium stars in those groups, and this will explain perfectly how it is coming to pass at present that we do not find any helium stars in those groups.

Therefore, finally, our answer to the question: How does it come to pass that in the second stream or cloud we find hardly any helium stars, would be because at some time the nebulous matter must have been exhausted in this cloud.

As to the first stream or star cloud, we similarly conclude that the nebulous matter must not yet have been exhausted, or, if so, only at a very recent period.

It has been my aim to show, not that much has been done, but that there is a beginning; not that we have entered far into the promised land, the land lying open to the human view so temptingly since the first man looked up to the sky, but that a few pathways are being mapped out, along which we may direct a hopeful attack. Our problems now take a more definite form, and even if we are never to solve them completely, let us remember the words of the poet:

> If God held in His right hand all truth, and in His left nothing but the ever-ardent desire for truth, even with the condition that I should err forever, and bade me choose, I would bow down to His left, saying, "Oh, Father, give, for truth is but for Thee alone."

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PRESENTATION OF MEDALS BY THE PRESIDENT OF THE UNITED STATES.

THE WHITE HOUSE, APRIL 23, 1913.

Dr. IRA REMSEN. Mr. President, I have the honor to present to you Dr. Woodward, the president of the Carnegie Institution of Washington, and a member of the Council of the National Academy of Sciences, who will in turn present to you those who are to receive medals on the recommendation of the academy.

We thank you, sir, for helping us in this ordeal.

Dr. WOODWARD. In compliance with the wishes of Prof. James Craig Watson, a member of the National Academy of Sciences, and an eminent expositor of celestial mechanics and orbital astronomy, and in accordance with the provisions of a fund bequeathed by him to the academy, a gold medal and an accompanying honorarium are awarded from time to time for meritorious work in astronomical science. Such testimonials of appreciation and approval have been hitherto bestowed upon Benjamin Apthorp Gould, Edward Schönfeld, Seth Carlo Chandler, and Sir David Gill.

It is now the decision and the pleasure of the academy to make an award to Prof. Jacobus Cornelius Kapteyn, of the University of Groningen, in recognition of his bold and penetrating researches in the problem of the structure of the stellar universe. Out of the apparent chaos of the stars he has shown us those elements of order and system which are fundamental to successful procedure in the solution of this grand problem. To an indispensable keenness of perception and capacity for generalization he has added the equally essential qualities of courage, optimism, and imagination, all disciplined by the rigors of patient observation and refined analysis. Preeminent as one of the pioneers in this domain of astronomy, his work is no less praiseworthy for its intrinsic merit than for the fruitful stimulus it has given his colleagues everywhere in the same domain. He has thus helped to make a science always peculiarly cosmopolitan still more beneficent than it has hitherto been in promoting that fraternity of interest which leads to international amity and comity.

It is therefore the pleasant duty of the academy, on this occasion of its jubilee anniversary, and in the presence of this assembly, to request the President of the United States to convey the Watson medal and honorarium to Prof. Kapteyn.

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President WILSON. Dr. Woodward, I feel very much at home in a company made up like the companies in which I have been accustomed to keep a straight face. Notwithstanding my knowledge of the circumstances and although I have long lived in an atmosphere of studies of this sort, I have discovered that the atmosphere is a nonconductive medium and none of the learning of this sort has reached me. I can therefore speak with perfect disinterestedness with regard to matters of this sort.

But, speaking seriously, sir, it is a peculiar pleasure to me to act in the name of this great society, so long associated in an advisory capacity with the Government of the United States, in bestowing this medal upon so distinguished a recipient. Prof. Kapteyn, I take great pleasure in presenting it to you.

Dr. WOODWARD. For the promotion of astrophysical research and discovery and in memory of Dr. Henry Draper, a member of the National Academy of Sciences, himself a pioneer in the newer science of astrophysics, his widow, Mary Anna Palmer Draper, deeded to the academy, in 1883, a fund the income from which is used for the award of a gold medal in recognition of work already done, or for the direct promotion of investigation in this science. Draper medals have been awarded heretofore to Samuel Pierpont Langley, Edward Charles Pickering, Henry Augustus Rowland, Herman Carl Vogel, James Edward Keeler, Sir William Huggins, George Ellery Hale, William Wallace Campbell, and Charles Greeley Abbot.

On this occasion the academy announces its award of the Draper Medal to M. Henri Deslandres, director of the Astrophysical Observatory at Meudon, France.

More than a century ago the annals of science were rendered forever memorable by the contributions of three illustrious Frenchmen, Lagrange, Laplace, and Lavoisier. They set standards of excellence for investigation and for exposition which have since served as models for the world of science. It is with the spirit and with the thoroughness of these masters that M. Deslandres has pursued the rapidly expanding fields of astrophysics during the past quarter of a century, until he has become one of the preeminent leaders of this science. His work of necessity extends to a wide range of activities, embracing physical observations of solar eclipses, investigations of electric and magnetic phenomena of the sun, contributions to our theories of auroras, new stars, and nebulæ, studies of spectra of the sun, stars, and comets, and photographic determinations of the rotation periods of planets. His researches with and improvements of the spectroheliograph are especially noteworthy, for he has thus been able to show the structure and the physical nature of the sun's gaseous mass at varying depths from its turbulent

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surface. In recognition of the high merits of these contributions to science and in commendation of his effective organization of the Meudon Observatory the academy bestows upon him the Draper medal.

In the absence of M. Deslandres the President of the United States is requested to deliver this medal to His Excellency the Ambassador from France for transmission to our eminent colleague.

President WILSON. Your Excellency, I am very sorry that the distinguished recipient of this medal could not be present, but it gives me a great deal of pleasure, as the representative of the United States, to place it in your hands, sir, the distinguished representative of a nation which has always been our very much esteemed friend.

Dr. WOODWARD. A year after the death, in 1910, of Prof. Alexander Agassiz, a former president of the academy, his friend and distinguished colleague, Sir John Murray, conveyed to the academy a trust fund for the purpose of founding a commemorative medal to be known as the Alexander Agassiz gold medal and to be awarded from time to time to an individual of any country for meritorious contributions to the science of oceanography. On this occasion the academy announces its first award of this medal to Dr. Johan Hjort, director of the Norwegian fisheries.

Long eminent for their contributions to knowledge in all branches of science, it is a noteworthy fact that in recent decades our Scandinavian colleagues have proved themselves preeminent in the sciences of the atmosphere and hydrosphere of our planet. They have been especially happy in applying recondite theory to effective account in meteorology and in hydrography, proving in the most conclusive manner that there is no antithesis between sound theory and safe practice. Conspicuous amongst those who have contributed to this advance is the director of the Norwegian fisheries, who combines in a singular degree the capacities of the investigator, the administrator, and the luminous expositor. His encyclopedic work, in collaboration with Sir John Murray, on "The depths of the ocean," based largely on the researches conducted by him on the recent voyage of the Norwegian steamer *Michael Sars* in the North Atlantic, is at once a compendium for the expert, a source of instruction for the student, and a foundation for future progress in this domain of science. In appreciation of these achievements, so important in abstract research and so praiseworthy for their economic applications, the academy makes to him this first award of the Alexander Agassiz gold medal. In the absence of Dr. Hjort the President of the United States is requested to convey this medal to His Excellency the Minister from Norway.

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President WILSON. Your Excellency, it would have been most agreeable to us if we could have seen your fellow countryman who has looked into matters so deep and unstable, but it is a great pleasure in his absence to put this medal into your hands for transmission to him and to express to you our appreciation of his work and of your own relations with the United States.

Dr. WOODWARD. Our late colleague in the academy, Gen. Cyrus Buel Comstock, member of the Corps of Engineers of the United States Army, won distinction as Chief Engineer on the staff of Gen. Grant during the great civil conflict. But in the pursuit of his arduous vocation he found time also for the cultivation of science, and he is not less distinguished for his contributions to geodesy than for his service in the evolution of our Commonwealth.

His devotion to physical science is witnessed in his last will and testament, by which he conveyed to the academy a fund, the income from which may be used for the promotion of researches in electricity, magnetism, and radiant energy. Under the terms and conditions of this fund the academy now makes its first award under the designation "Comstock prize" of the sum of $1,500 to Prof. Robert Andrews Millikan of the University of Chicago.

It is a far cry from the adumbrations of Democritus and Lucretius to the modern doctrine of atomicity. But the demonstration of this doctrine, dimly foreseen more than 20 centuries ago, is the greatest achievement in physical science of the past two decades and one of the greatest in the history of science. It is now proved not only that what we call gross matter is atomic but that what we call electricity has also a granular or atomic structure. With rare acumen and with rare experimental skill Prof. Millikan has furnished the most direct and the most convincing proof of the existence of electric atoms or elements.

He has shown how to count these elements in any small electrical charge; he has rendered them almost tangible by showing in the clearest manner their visible effects; he has determined with superior precision the fundamental constant represented in the electrical charge of these atoms; he has demonstrated the equality in electrical charge of the positive and the negative ions in ionized gases; and he has made important additions to our knowledge of the molecular constitution and the kinetic phenomena of gases.

For these contributions to knowledge and for the original and refined methods of research he has developed and so successfully applied the academy honors him with this first recognition of superior merit as provided by the founder of the Comstock fund.

President WILSON. Prof. Millikan, in presenting this, may I not express my gratification that you have brought us out of the adumbrations of Lucretius into modern life, and say that I envy you the practice of a science so incalculable and exact?

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REPORT OF THE

NATIONAL ACADEMY OF SCIENCES

FOR THE YEAR

1915

WASHINGTON
GOVERNMENT PRINTING OFFICE
1916

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CONTENTS.

Page.

Letter of transmittal 5
Act of incorporation 7
Amendments 8
Proceedings 11
Meetings of the National Academy, 1915 12
Annual meeting—
Members in attendance 12
Business sessions 12
Assignment of biographical memoirs 12
Announcement of deaths 13
Reports of the president and treasurer 13
Report of the home secretary 13
Report of the directors of the Bache fund 13
Report of the trustees of the Watson fund 14
Report of the committee on the Henry Draper fund 16
Report of the committee on the J. Lawrence Smith fund 16
Report of the directors of the Benjamin Apthorp Gould fund 17
Report of the trustees of the Wolcott Gibbs fund 17
Report of the committee on the Murray fund 18
Report of the committee on award of Barnard medal 18
Report of the committee on solar research 19
Business from the council 19
Dues for 1916 19
Date for elections 19
International Association of Academies 19
Fiscal advisers of the academy 19
Autumn meeting 19
Bequest of Mrs. Mary Anna Palmer Draper 19
Report of editorial board of the Proceedings 20
Report of committee on historical objects 21
Report of the committee of chairmen of sections 21
Election of members of the council 22
Election of new members 22
Constitution 22
Rules 22
Committee personnel 22
Scientific sessions 23
April 19 23
April 20 23
April 21 24
Presentation of Henry Draper medal 24
Autumn meeting 24
Members in attendance 24

Digitized by Google

Meetings of the National Academy, 1915—Continued.
Autumn meeting—Continued.
Business sessions— Page.
Announcement of deaths since annual meeting ... 25
Publications issued ... 25
Committee changes ... 25
Board of directors of the Bache fund ... 25
Board of directors of the Wolcott Gibbs fund ... 25
Chairmen of sections ... 25
Auditing committee ... 26
Editorial board changes ... 26
Delegates ... 26
Committee on Panama Canal ... 26
Marsh fund ... 26
Consolidation of funds ... 26
Report of the committee on the Henry Draper fund ... 27
Name of the academy ... 27
Report of the Committee on the Medal for Eminence in the Application of Science to the Public Welfare ... 27
Award of the Medal for Eminence in the Application of Science to the Public Welfare ... 28
Report of the editorial board of the Proceedings ... 28
New rule ... 28
Scientific sessions—
November 15 ... 29
November 16 ... 29
November 17 ... 30
Deceased members:
Frederick W. Putnam ... 30
Paul Ehrlich ... 33
Annual report of the treasurer:
General review of financial transactions ... 36
Condensed statement of receipts and expenditures ... 37
Statement of assets and liabilities ... 39
Accounts with individual funds ... 42
Report of auditing committee ... 46
Appendices:
Appendix A.—Constitution of the National Academy ... 49
Appendix B.—Rules ... 56
Appendix C.—Organization of the academy, 1915-16 ... 62
Sections ... 62
Standing committees ... 64
Trust funds ... 64
Members of the National Academy of Sciences, December 31, 1915 ... 67
Honorary member ... 69
Foreign associates ... 70
Deceased members ... 71
Deceased foreign associates ... 74

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LETTER OF TRANSMITTAL.

NATIONAL ACADEMY OF SCIENCES,
January 27, 1916.

The Honorable THOMAS R. MARSHALL,
Vice President of the United States,
Washington, D. C.

SIR: I have the honor to transmit to you herewith the annual report of the president of the National Academy of Sciences for the year ending December 31, 1915.

Very respectfully,

ARTHUR L. DAY,
Home Secretary.

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ACT OF INCORPORATION.

AN ACT To incorporate the National Academy of Sciences.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That Louis Agassiz, Massachusetts; J. H. Alexander, Maryland; S. Alexander, New Jersey; A. D. Bache, at large; F. B. Barnard,[1] at large; J. G. Barnard, United States Army, Massachusetts; W. H. C. Bartlett, United States Military Academy, Missouri; U. A. Boyden, Massachusetts; Alexis Caswell, Rhode Island; William Chauvenet, Missouri; J. H. C. Coffin, United States Naval Academy, Maine; J. A. Dahlgren, United States Navy, Pennsylvania; J. D. Dana, Connecticut; Charles H. Davis, United States Navy, Massachusetts; George Engelmann, Saint Louis, Missouri; J. F. Frazer, Pennsylvania; Wolcott Gibbs, New York; J. M. Gilless,[2] United States Navy, District of Columbia; A. A. Gould, Massachusetts; B. A. Gould, Massachusetts; Asa Gray, Massachusetts; A. Guyot, New Jersey; James Hall, New York; Joseph Henry, at large; J. E. Hilgard, at large, Illinois; Edward Hitchcock, Massachusetts; J. S. Hubbard, United States Naval Observatory, Connecticut; A. A. Humphreys, United States Army, Pennsylvania; J. L. Le Conte, United States Army, Pennsylvania; J. Leidy, Pennsylvania; J. P. Lesley, Pennsylvania; M. F. Longstreth, Pennsylvania; D. H. Mahan, United States Military Academy, Virginia; J. S. Newberry, Ohio; H. A. Newton, Connecticut; Benjamin Peirce, Massachusetts; John Rodgers, United States Navy, Indiana; Fairman Rogers, Pennsylvania; R. E. Rogers, Pennsylvania; W. B. Rogers, Massachusetts; L. M. Rutherford, New York; Joseph Saxton, at large; Benjamin Silliman, Connecticut; Benjamin Silliman, junior, Connecticut; Theodore Strong, New Jersey; John Torrey, New York; J. G. Totten, United States Army, Connecticut; Joseph Winlock, United States Nautical Almanac, Kentucky; Jeffries Wyman, Massachusetts; J. D. Whitney, California; their associates and successors duly chosen, are hereby incorporated, constituted, and declared to be a body corporate, by the name of the National Academy of Sciences.

SEC. 2. *And be it further enacted,* That the National Academy of Sciences shall consist of not more than fifty ordinary members, and the said corporation hereby constituted shall have power to make its

[1] The official list of members gives the name of F. A. P. Barnard.
[2] The official list of members gives the name of J. M. Gilliss.

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own organization, including its constitution, by-laws, and rules and regulations; to fill all vacancies created by death, resignation, or otherwise; to provide for the election of foreign and domestic members, the division into classes, and all other matters needful or usual in such institution, and to report the same to Congress.

SEC. 3. *And be it further enacted,* That the National Academy of Sciences shall hold an annual meeting at such place in the United States as may be designated, and the academy shall, whenever called upon by any department of the Government, investigate, examine, experiment, and report upon any subject of science or art, the actual expense of such investigations, examinations, experiments, and reports to be paid from appropriations which may be made for the purpose, but the academy shall receive no compensation whatever for any services to the Government of the United States.

Approved, March 3, 1863.

AMENDMENTS.

AN ACT To amend the act to incorporate the National Academy of Sciences.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the act to incorporate the National Academy of Sciences, approved March third, eighteen hundred and sixty-three, be, and the same is hereby, so amended as to remove the limitation of the number of ordinary members of said academy as provided in said act.

Approved, July 14, 1870.

AN ACT To authorize the National Academy of Sciences to receive and hold trust funds for the promotion of science, and for other purposes

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the National Academy of Sciences, incorporated by the act of Congress approved March third, eighteen hundred and sixty-three, and its several supplements, be, and the same is hereby, authorized and empowered to receive bequests and donations and hold the same in trust, to be applied by the said academy in aid of scientific investigations and according to the will of the donors.

Approved, June 20, 1884.

AN ACT To amend the act authorizing the National Academy of Sciences to receive and hold trust funds for the promotion of science, and for other purposes.

Be it enacted by the Senate and House of Repersentatives of the United States of America in Congress assembled, That the act to authorize the National Academy of Sciences to receive and hold trust funds for the promotion of science, and for other purposes, approved June twentieth, eighteen hundred and eighty-four, be, and the same is hereby, amended to read as follows:

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"That the National Academy of Sciences, incorporated by the act of Congress approved March third, eighteen hundred and sixty-three, be, and the same is hereby, authorized and empowered to receive, by devise, bequest, donation, or otherwise, either real or personal property, and to hold the same absolutely or in trust, and to invest, reinvest, and manage the same in accordance with the provisions of its constitution, and to apply said property and the income arising therefrom to the objects of its creation and according to the instructions of the donors: *Provided, however,* That the Congress may at any time limit the amount of real estate which may be acquired and the length of time the same may be held by said National Academy of Sciences."

SEC. 2. That the right to alter, amend, or repeal this act is hereby expressly reserved.

Approved, May 27, 1914.

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ANNUAL REPORT

OF THE

NATIONAL ACADEMY OF SCIENCES.

The year 1915 is conspicuous in the record of the activities of the academy because of the establishment at the beginning of the year of a monthly scientific journal called the Proceedings of the National Academy of Sciences. The undertaking was entered upon without the aid either of an endowment or of a government subvention, but through voluntary subscription by members and friends under the pressure of an acute need for a publication broad enough in scope to include all the interests of the academy, and one which should offer an opportunity for the prompt and accurate announcement of the scientific discoveries of members and others.

It is not the purpose of the proceedings to include long or detailed papers which appear more appropriately in the special journals conducted by scientific societies, but rather to supplement this detailed record, which is prepared usually for restricted circulation within the branch of science in which it originates, with an early general announcement of the essential features and results of important investigations both in the interest of scientific progress and of general knowledge.

It is particularly important, for example, that the results of American research should be brought to the attention of foreign investigators both in Europe and in South America, partly for the purpose of avoiding duplication of effort and partly in order to secure appropriate recognition of the great increase in the productiveness of American research during recent years. The National Academy, through its official affiliation with the representative scientific organizations of other nations and its close relations with a great number of unofficial foreign societies, is obviously in a peculiarly favorable position to disseminate the results of American scientific work, if indeed it is not definitely the duty of the academy to do so. No appropriate organ for the distribution of concise, authentic reports covering the whole broad field of American scientific studies has existed in the United States hitherto, and American research in consequence is much less well known abroad to-day than it is entitled to be.

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There is already evidence that the present effort will be successful in correcting this situation. The mailing list of the Proceedings already includes more than 900 foreign institutions of learning and research, distributed in all parts of the world, in addition to its American correspondents. To this great body of scientific workers the academy has presented, through its Proceedings, this first year which has just closed, 166 papers. To the academy this is a duty long unfulfilled rather than a privilege, perhaps, but its value to American scientific research is already clearly demonstrated and is likely to increase rapidly in this and following years.

MEETINGS OF THE NATIONAL ACADEMY.

During the year 1915 the academy held two stated meetings, the annual meeting in April at Washington and the autumn meeting in November, at New York City.

ANNUAL MEETING.

The sessions were held in the United States National Museum and in the Oak Room of the Raleigh Hotel, Washington, D. C., April 19, 20, 21, 1915. Fifty-eight members were present, as follows: Becker, Boltwood, Britton, Bumstead, Cattell, Chittenden, Clark (W. B.), Clarke (F. W.), Clarke (J. M.), Conklin, Coulter, Crafts, Cross, Dall, Davenport, Davis, Donaldson, Fewkes, Frost, Goodale, Hague, Hale, Harper, Harrison, Hayford, Hillebrand, Holmes, Howell, Jennings, Loeb, Mall, Meltzer, Mendel, Merriam, Michelson, Moore, Morgan, Morley, Nichols (E. L.), Noyes (A. A.), Noyes (W. A.), Osborn (H. F.), Osborne (T. B.), Parker, Pickering, Pirsson, Ransome, Reid, Remsen, Schuchert, Scott, Smith (E. F.), Walcott, Webster, Welch, Wheeler, White, Woodward.

BUSINESS SESSIONS.

The president announced that the preparation of biographical memoirs of deceased members had been assigned as follows:

Bowditch, Henry P., to Walter B. Cannon,
Davidson, George, existing biography approved.
Gould, Benjamin Apthorp, to George C. Comstock.
Mitchell, Henry, to John F. Hayford.
Mitchell, Silas Wier, to William H. Welch.
Chandler, Seth Carlo, to William L. Elkin.
Peirce, Benjamin Osgood, to E. H. Hall.
Holden, Edward Singleton, to W. W. Campbell.
Hill, George William, to E. W. Brown.
Peirce, Charles Sanders, to J. McK. Cattell.
Gill, Theodore Nicholas, to William H. Dall.
Minot, Charles Sedgwick, to F. P. Mall.
Billings, John Shaw, to Fielding H. Garrison.

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The president announced the death, since the autumn meeting, of one foreign associate:

Auwers, G. F. J. Arthur, elected 1883, died January 24, 1915.

REPORTS OF THE PRESIDENT AND THE TREASURER.

The reports of the president [1] and of the treasurer [2] for 1914, as transmitted to the Senate of the United States by the president of the academy, were presented in their printed form and approved.

REPORT OF THE HOME SECRETARY.

The President of the National Academy of Sciences.

SIR: I have the honor to present the annual report of the home secretary of the National Academy of Sciences for the year ending April 21, 1915.

The memoir of the National Academy of Sciences, volume 12, part 1, and bearing the title, "Monograph of the Bombycine Moths of North America," by A. S. Packard, edited by T. D. A. Cockerell, has been published and distributed to the members, foreign associates, institutions, and reference libraries; volume 12, part 3, of the memoirs, entitled, "The Turquois," by Joseph E. Pogue, has also been published and distributed; part 2 of this same volume entitled, "Variations and Ecological Distribution of the Snails of the Genus Io," by Charles C. Adams, has received final consideration, and is now waiting to be bound at the Government Printing Office; the memoir forming volume 13, being "A Catalogue of the Meteorites of North America," by Oliver C. Farrington, only awaits press work and binding before it is issued.

The biographical memoirs of John Wesley Powell, Charles A. Schott, and Miers Fisher Longstreth have been published. The publication of the memoir of Peter Lesley, by William M. Davis, has been approved by the committee on publication, and the biography of Henry Morton, by Edward L. Nichols, has been printed and awaits the portrait.

Three members have died since the last annual meeting: Theodore Nicholas Gill, on September 25, 1914, elected in 1873; Charles Sedgwick Minot, on November 19, 1914, elected in 1897; and Henry Lord Wheeler, on October 30, 1914, elected in 1909.

Of our foreign associates, Eduard Suess died on April 26, 1914, elected in 1898; August Weismann died on December 5, 1914, elected in 1913; Hugo Kronecker died on June 6, 1914, elected in 1901; G. F. J. Arthur Auwers died on January 24, 1915, elected in 1883.

There are 134 active members on the membership list, one honorary member, and 43 foreign associates.

ARTHUR L. DAY,
Home Secretary.

REPORT OF THE DIRECTORS OF THE BACHE FUND.

The serious illness of Dr. Charles S. Minot, the chairman of the board of directors of the Bache fund, made it difficult to carry on the work of the board for several months. His death in November last left a vacancy hard to fill as he was most conscientious in the performance of his duties. After careful consideration the two remaining members of the board elected Prof. Ross G. Harrison the third member and he accepted. In turn the board elected the undersigned chairman.

Since the last annual meeting of the academy the following appropriations have been made:

[1] Report of the National Academy of Sciences for the year 1914, pp. 11–56. [2] Idem, pp. 57–65.

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No. 182. W. C. Kendall. $600. April 30, 1914. Toward the expenses of illustrations in color and incidental expenses in connection with Part II (*Salmonidæ*) Fishes of New England to be published by the Boston Society of Natural History.

No. 183. C. G. Abbot. $250. June 29, 1914. To complete and test on Mount Wilson in California an apparatus consisting of a concave cylindric mirror of about 100 square feet surface adapted to heat oil to circulate through a reservoir containing ovens and water pipes, and thereby to utilize solar radiation for cooking and for heating water for domestic purposes.

No. 184. P. W. Bridgman. $500. September 14, 1914. To continue the work on high pressures, especially to investigate the phase changes brought about in various substances by very high pressure.

No. 185. Robert W. Hegner. $160. December 26, 1914. To determine the visible changes that take place during the differentiation of the germ cells in the embryos of hermaphroditic animals, and to discover, if possible, the cause of these changes.

No. 186. J. Voûte. $800. February 9, 1915. For the determination of parallaxes of southern stars by transits. The Bache fund has heretofore granted $1,000 for this research. It is conducted at the Royal Observatory, Cape of Good Hope, wholly at the expense of Mr. Vûote, except for these grants.

No. 187. H. H. Lane. $500. April 14, 1915. To make a comparative study of the embryos and young of various mammals in order to determine, by physiological experimentation and morphological observations, the correlation between structure and function in the development of the special senses.

IRA REMSEN,
Chairman.

APRIL, 1915.

REPORT OF THE TRUSTEES OF THE WATSON FUND.

The will of the late James Craig Watson provided "for the promotion of astronomical science," but he expressed the wish that a medal should be given and that tables should be prepared of the motions of all the planets discovered by him. This last wish has now been carried out in a most satisfactory manner by Prof. A. O. Leuschner, so that the income which has been used for this purpose during the last 14 years is now available for the promotion of astronomical science in other directions.

The undersigned accordingly recommend the following votes:

Resolved, That the Watson medal and the sum of $100 be awarded to Prof. Armin Otto Leuschner, for the skill and ability which he has shown in supervising the preparation of tables of the Watson asteroids, involving original methods, and leading to results of much value to celestial mechanics.

Resolved, That the sum of $500 from the income of the Watson fund be appropriated to Prof. John A. Miller, director of the Sproul Observatory, for measuring plates already taken for the determination of stellar parallaxes.

Resolved, That the sum of $300 be appropriated from the income of the Watson fund to Mr. John E. Mellish, to enable him to undertake observations at the Yerkes Observatory.

E. C. PICKERING, *Chairman.*
W. L. ELKIN.
EDWIN B. FROST.

APRIL 2, 1915.

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MARCH 25, 1915.

Prof. E. C. PICKERING,

Chairman Watson Trustees of the National Academy of Sciences,

Harvard College Observatory, Cambridge.

DEAR SIR: I beg to submit the following statement of the condition of the Watson work on March 1, 1915. This is a continuation of the reports submitted March 21, 1912; April 5, 1913; and April 1, 1914.

1. A year ago I reported that—

(*a*) In addition to the 12 planets published, 3 planets, (79) Eurynome, (150) Nuwa, and (121) Hermione were ready to be put into manuscript form.

(*b*) That (132) Aethra would be assigned to some other graduate student unless Mr. Champreux gave assurance that he would make progress. You will remember that this planet is not part of our list, as it is considered lost.

(*c*) That (175) Andromeda was completed on the basis of our revision of von Zeipel's tables.

(*d*) That the perturbations (106) Dione of the Hecuba group were developed and that it remained to make comparison between theory and observation.

(*e*) That (100) Hecate and (104) Clymene required a comparison between theory and observation, and a correction of the elements.

(*f*) That of the remaining two planets, in the case of (94) Aurora, a complete revision of the perturbations which had originally been done by Hansen's theory would be required on the basis of von Zeipel's theory, and that no work had as yet been undertaken on (168) Sibylla, which also belongs to the Hecuba group.

In making report at this time I shall refer to each of the items that was mentioned as incomplete in my last report under (*a*) to (*f*).

2. (*a*) and (*c*). These four planets were reported as entirely completed last year.

(*b*) (132) Aethra. Mr. Champreux has done nothing further, and Mr. W. D. Alter has recently undertaken the investigation of this case. As Luther's final elements, accepted by the Jahrbuch, made the mean motion of this planet very nearly three times that of Jupiter, its loss has been a matter of great theoretical interest. Owing to the great ease and accuracy of determining orbits by my own method, it seemed desirable to deduce a new orbit from the original observations, of which there were two sets, extending in all over 22 days. One set of these observations was made by Watson with a ring micrometer at Ann Arbor, and the other set was made with a Filar micrometer at Marseilles, France. Watson computed two orbits, resulting in daily motions of 980″ and 846″, respectively. Watson's orbits were based entirely on his own ring micrometer observations. Luther applied systematic corrections to these. He investigated the star places and produced a definitive orbit on the basis of both the Ann Arbor and Marseilles observations, obtaining a mean motion of 904″, and this orbit has been accepted by the Jahrbuch and is the one on the basis of which extensive but fruitless searches have been made for this planet. Mr. Alter's new orbit is based entirely on the Marseilles observations, while Watson's orbits were based entirely on the ring micrometer observations. Mr. Alter has obtained a reliable orbit which agrees exactly with the rejected orbit of Watson, getting a mean motion of 844″ as compared with that of Watson of 846″. This puts an entirely new aspect on the whole problem and proves that the search for this planet has been unavailable on account of the error in the accepted elements, about 1′ of arc per day in the mean motion, which for a number of years would of course make it impossible to locate it. Mr. Alter will continue this problem, compute the perturbations without charge to the Watson trustees, and I have no doubt will be able to decide what has become of the planet.

(*d*) The work on (106) Dione is now entirely completed.

(*e*) Nothing further has been done on (100) Hecate but in the case of (104) Clymene a complete revision by von Zeipel's theory is nearly completed.

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(*f*) Nothing further has been done on (94) Aurora, but (168) Sibylla has been completed entirely on the basis of von Zeipel's theory.

3. The investigation of the perturbations of the Watson asteroids is therefore completed with the exception of a final revision of (100) Hecate and (94) Aurora, both of which, as stated above, have been treated by Hansen's method with unsatisfactory results. We do not anticipate much difficulty in finally disposing of these two cases, on account of the very favorable conditions existing in them as compared to (175) Andromache, which readily yielded to our investigation.

4. Under these circumstances it appears certain that the work may be completed with the balance of the appropriation for the current year. Just how far we shall get with the clerical work of preparing the manuscript on the available balance I can not say at this time, but the cost of this clerical work will be slight. At any rate it need not be considered until after the whole volume has been printed. I can advance the same, if necessary, in the meantime.

5. The total appropriation made last year was $1,031.45, which included a balance of $71.45 of the preceding year and an allowance of $80 per month for the current year. Miss Sophia H. Levy continues as chief computer, with the assistance of Mr. O. D. Shane, the monthly expense being $80. Up to March 1 I have expended $580, leaving available for the completion of the work the sum of $451.45. As stated above this, I think, will be sufficient, possibly exclusive of the clerical work of preparing the manuscript and seeing the same through the press.

Respectfully submitted,

A. O. LEUSCHNER.

REPORT OF THE COMMITTEE ON THE HENRY DRAPER FUND.

The committee unanimously recommends to the academy that the following grants for research be approved:

Five hundred dollars to Dr. W. W. Campbell, director of the Lick Observatory, for the purchase and construction of spectrographic and other apparatus for use with the Crossley reflector.

Two hundred and fifty dollars to Dr. S. A. Mitchell, director of the Leander McCormick Observatory, for the purchase of a machine for measuring astronomical photographs.

GEORGE E. HALE,
Chairman.

REPORT OF THE COMMITTEE ON THE J. LAWRENCE SMITH FUND.

In regard to researches now in progress or lately completed which have received aid from this fund the committee reports as follows:

Grant No. 3. Edmund Otis Hovey, curator in geology and paleontology in the American Museum of Natural History, New York, received in 1910, a grant of $400 in aid of the study of certain meteorites. Metallographic and chemical examinations are in progress. Dr. Hovey is at this time out of the country.

Grant No. 4. Prof. C. C. Trowbridge of the department of physics in Columbia University received in 1910 a grant of $400 in aid of his study of the luminous trains of meteors. The academy has also made further grants of $250 in 1912, of $250 in 1913, and of $250 in 1914. The important work of collecting, verifying, and tabulating records of observations of luminous trains has been diligently pursued. Lately, the collection and preparation for publication of drawings of luminous trains has been undertaken. In accordance with the vote of the academy in 1912, three payments have been made from this grant and it is expected that the fourth and last installment will be required during the current year.

Grant No. 5. Dr. George P. Merrill, curator in the department of geology in the United States National Museum, received a grant of $200 in 1910, and of $200 in 1911.

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to aid in the study of the occurrence of certain elements suspected to be present in small quantities in some meteorites. This work has been successfully completed, and the final report is ready for submission to the academy; the report contains a tabulation of all available trustworthy analyses of meteorites, and is accompanied by a special paper on the occurrence in meteorites of francolite or some allied phosphatic mineral in place of the apatite of terrestrial rocks.

The committee recommends that the meteorites remaining from the purchases by Dr. Merrill be deposited by the National Academy of Sciences in the United States National Museum.

Prof. S. A. Mitchell, University of Virginia, has applied for a grant of $500 to aid in the computation of orbits of meteors. Dr. Charles P. Olivier, president of the American Meteor Society, has computed orbits from some 9,000 observations of meteor paths, and has some thousand observations awaiting reduction. He has published two important papers containing several hundred computed orbits. The committee recommends the grant of $500 to Prof. S. A. Mitchell, to aid in computations of orbits of meteors.

The cash balance of income now available for grants is $874.87, and the invested income is $1,532.50.

EDWARD W. MORLEY,
Chairman.

REPORT OF THE BOARD OF DIRECTORS OF THE BENJAMIN APTHORP GOULD FUND.

The income balance of the Gould fund is now, in cash, $404.64; in readily negotiable securities, $4,057.50; and in an unpaid grant to the Astronomical Journal, $1,000.

F. R. MOULTON,
Chairman.
E. E. BARNARD.

REPORT OF THE DIRECTORS OF THE WOLCOTT GIBBS FUND.

The directors of the Wolcott Gibbs fund for chemical research have the honor to present their annual report to the National Academy of Sciences.

Since the last report three grants have been made from the income of the fund as follows:

III. One hundred dollars to Prof. W. J. Hale, Ann Arbor, to pay for assistance in a research on derivatives of 2.3-diacetylpentadiene, voted May 15, 1914.

Prof. Hale reports that he has prepared the cyclopentadiopyridazine and the corresponding phenyl compound, and determined their composition. He hopes to finish the research before the summer vacation.

IV. Two hundred dollars to Prof. W. D. Haskins, University of Chicago, for making a special potentiometer and galvanometer to study cobaltammines and ternary systems of fused salts. Voted November 25, 1914.

Prof. Haskins reports that a beginning has been made on the work in spite of his severe sickness and the fact that the war has prevented him from obtaining part of the apparatus from Germany.

V. A second grant of $100 to Prof. Mary E. Holmes of Mount Holyoke College for assistance in her work on the electrolytic determination of cadmium. Voted March 18, 1915.

Prof. Holmes reports that she has purchased platinum electrodes of a new form, and with these has studied the deposition of cadmium and copper, so that she is now beginning to study the electrical separation of cadmium from other metals.

The unexpended income of the fund amounted on April 1 to $111.99.

C. L. JACKSON,
Chairman.

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REPORT OF THE COMMITTEE ON THE MURRAY FUND.

The committee on the Sir John Murray fund has to report that during the year 1913 there were exceptional and extraordinary expenses due to the designing and striking off of the Agassiz medal, rendered necessary by the terms of the gift. The committee deemed best not to touch the original fund, and the income derived from this fund at that time was not sufficient to meet these expenses. The committee therefore, with the consent of the treasurer, borrowed from the general fund of the academy a sum sufficient to meet these needs. On December 31, 1914, a portion of this indebtedness was repaid from the income derived from the Murray fund, leaving about $300 still due. By the end of the present calendar year the entire indebtedness of the Murray fund to the general fund will have been paid, leaving the Murray fund out of debt and prepared to meet the legitimate requirements of the fund.

This Murray fund ($6,000) is now drawing interest, and your committee in charge of this fund will be prepared in another year to recommend the bestowal of a second Agassiz medal, as intended by the donor of the gift, Sir John Murray, or possibly to suggest to the academy a contribution to further the science of oceanography.

ARNOLD HAGUE,
Chairman.

REPORT OF THE COMMITTEE ON AWARD OF BARNARD MEDAL FOR MERITORIOUS SERVICE IN SCIENCE.

Your committee on award of the Barnard medal begs leave to submit the following report:

The committee has considered many candidates, of which several have been esteemed generally worthy of recommendation for the medal in question. The terms of the specifications concerning the award of this medal impose, however, certain restrictions which must be borne in mind. These specifications are contained in the following paragraph from the will of the founder of the fund provided for the quinquennial bestowal of this medal:

"A gold medal of the value of $200, established by the provisions of the will of President Barnard and endowed by him, known as the 'Barnard medal for meritorious service to science,' is awarded quinquennially to such person, if any, whether a citizen of the United States or any other country, as shall within the five years next preceding have made such discovery in physical or astronomical science, or such novel application of science to purposes beneficial to the human race, as in the judgment of the National Academy of Sciences of the United States shall be esteemed most worthy of such honor."

Observing the limitations here set forth and giving careful attention to the individual merits of the candidates considered, your committee has reached the unanimous conclusion that William Henry Bragg, professor of physics in the University of Leeds, and his son, W. L. Bragg, now a student at the University of Cambridge, should be recommended for the next award. The reasons which have led your committee to this conclusion are briefly indicated in the following statement:

The doctrine of atomism, foreshadowed poetically by Leucippus, Democritus, and Lucretius, and raised to the dignity of an exceedingly fruitful hypothesis by Dalton and the modern schools of chemists and physicists, is now approaching the long-sought stage of verification and demonstration. Since the time of Dalton a multitude of investigators have contributed continuously toward the attainment of this advanced stage, but progress has been remarkably cumulative and rapid during the past quarter of a century. The fundamental importance of the several fields of research in which the atomic structure of matter is now being established is sufficiently indicated by the fact that four preceding awards of the Barnard medal have been made for researches in these fields. But this importance is now emphasized

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anew by the recommendation that the next award of the Barnard medal be made to Messrs. W. H. and W. L. Bragg, father and son, for highly meritorious work in the same fields.

About three years ago Dr. Laue and his collaborators of the University of Munich produced some remarkable photographs by passing a narrow beam of X-rays through a crystal of zinc blende. These photographs revealed geometrical figures strikingly suggestive of the molecular structure attributed by crystallographers to such minerals. The bearings of this discovery were quickly appreciated by a number of investigators, and extraordinary advances in crystallography, in the theory of X-radiation, and in the application of X-rays to the study of matter, have rapidly followed. In securing these advances the Messrs. Bragg have been preeminent. By means of a rare combination of experimental skill and theoretical insight they have been able to show that X-rays are essentially light rays of excessively short wave length and that crystalline structure is definitely molecular. They have determined the order of wave length of X-rays and they have also determined the order of the intervals which separate the molecules in certain crystalline forms. In a noteworthy series of luminous publications and in an equally noteworthy series of masterly public expositions they have supplied the initial methods and furnished many of the preliminary results which must lead to a still more productive era in the advancement of molecular physics and hence in the advancement of the entirety of physical science.

In view of these achievements your committee hereby unanimously recommends that Messrs. W. H. and W. L. Bragg be proposed to Columbia University for an award of the Barnard medal for the year 1915.

For the committee.

R. S. WOODWARD.

REPORT OF THE COMMITTEE ON SOLAR RESEARCH.

The committee begs to call the attention of the academy to the publication of Volume IV of the Transactions of the International Union for Cooperation in Solar Research, which contains the complete proceedings of the last meeting in Bonn, reports of the various committees, resolutions adopted by the Union, and several scientific papers on solar and stellar phenomena.

The four volumes of transactions already published by the Solar Union may be obtained from Messrs. Longmans, Green & Co., Fourth Avenue and Thirtieth Street, New York, at $2.50 per volume.

GEORGE E. HALE, *Chairman.*

BUSINESS FROM THE COUNCIL.

Recommended:

(*a*) That the annual dues for 1915 be $5.

(*b*) That the election of new members and of two members of the council be held Wednesday morning, April 21, 1915.

(*c*) That the treasurer be authorized to pay the annual subscription of 200 francs to the International Association of Academies.

(*d*) That the American Security & Trust Co., of Washington, D. C., and Spencer Trask & Co., of New York City, be designated fiscal advisers of the academy for 1915–16.

(*e*) That the time and place of the autumn meeting, 1915, be left to the president and the home secretary with power.

(*f*) That the following bequest from Mrs. Mary Anna Palmer Draper be accepted:

[Extract from the will of Mrs. Mary Anna Palmer Draper, page 7, section 9 (second paragraph).]

I give and bequeath to the National Academy of Sciences, Smithsonian Institution, Washington, D. C., the sum of twenty-five thousand dollars ($25,000).

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RESOLUTION.

The National Academy of Sciences, desiring to express its deep appreciation of the recent bequest of Mrs. Henry Draper, places this minute upon its records.

The name of Draper occupies a unique place in the annals of science in America. John William Draper, author of "The Intellectual History of Europe," was a pioneer of American research, adding by his own investigations to the progress of the first half of the nineteenth century. Henry Draper, his son, an early member of the National Academy, was one of the founders of astrophysics. He was the first to photograph nebulæ and the first to secure photographs of stellar spectra of sufficiently perfect definition to show the lines. His researches, made with instruments of his own construction, are being continued on a large scale by the Harvard College observatory. Mary Anna Palmer Draper, wife of Henry Draper, and his devoted assistant in astrophysical research, has endowed the Henry Draper Memorial to continue his investigations. Her interest in the National Academy was manifested by her constant attendance at its meetings, her receptions of the academy at her home in New York, and by two important gifts. The first of these, made in 1883, established the Draper gold medal for researches in astronomical physics, and provided, through excess income, for the assistance of many investigations in this field. This gift has now been supplemented by a bequest of $25,000, to be known as the John S. Billings fund, the income of which will be applied at present toward the support of the recently established Proceedings.

The academy feels that this appropriate memorial of one of its leading members, providing funds greatly needed for a new publication, and closing a long series of exceptional services to science, will be widely and gratefully appreciated.

A copy of this resolution was directed to be forwarded to the family of Mrs. Draper.

REPORT OF THE EDITORIAL BOARD OF THE PROCEEDINGS.

The editorial board of the Proceedings reports to the academy that four numbers of the Proceedings have now been issued, containing 67 original papers in addition to the report of the autumn meeting, notices of scientific memoirs, and announcements. These numbers have consisted of 258 pages, an average of 64 pages per number and of about 4 pages per article. The papers are distributed among different sciences as follows: Mathematics, 11; astronomy, 11; physics, none; chemistry, 11; geology, 2; paleontology, 1; botany, 4; zoology (including genetics), 12; physiology, 8; pathology, none; anthropology, 5; psychology, 2. It will be noticed that the subjects of physics, of geology and paleontology, and of pathology have been very inadequately represented; and the editorial board urges members of the academy in these fields to endeavor to remedy this situation.

An edition of 3,000 copies of these four numbers has been printed. Of this edition about 900 are to be sent abroad to the libraries of universities and other active research institutions upon a mailing list prepared with great care by the foreign secretary, aided by members of the editorial board. Of this edition 1,200 copies have also been distributed in this country by the home secretary to important libraries and to the thousand persons whose names are starred in Cattell's American Men of Science.

ARTHUR A. NOYES, *Chairman.*

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REPORT OF THE COMMITTEE ON THE COLLECTION OF HISTORICAL PORTRAITS, MANUSCRIPTS, AND INSTRUMENTS, INCLUDING INSTRUMENTS PURCHASED AT THE EXPENSE OF THE TRUST FUNDS.

Your committee on the collection of historical portraits, manuscripts, and instruments, including instruments purchased at the expense of the trust funds which are no longer needed for the original purpose, begs to report as follows:

That the collection of portraits of the members of the academy has been brought together and arranged alphabetically.

That the foreign secretary has turned over the medal from the Groningen Academy celebrating its three hundredth anniversary.

That the following apparatus was presented by Mrs. Henry Draper and has been deposited in the United States National Museum:

1 slit.
1 spectrum photograph (broken).
1 liquid prism cell.
1 double liquid prism cell.
1 prism with 2-inch faces.
1 package—attempts of Henry Draper to rule gratings.
1 speculum metal ruled surface 2 inches square.
1 Bunsen burner.
2 boxes, 12 photographs each.
1 box, 50 photographs.
1 box, 34 photographs.
1 box, 22 photographs.
1 box, 15 daguerreotypes.
1 box, 7 photographs.
13 Geisler ? tubes.

CHARLES D. WALCOTT, *Chairman.*

REPORT OF THE COMMITTEE OF CHAIRMEN OF SECTIONS.

The committee of chairmen of sections of the academy recommends the following rule in regard to the nomination of members:

The chairman of each section of the academy shall submit to the members of his section, not later than November 1 of each year, a ballot containing the names of all those persons who received not less than 2 votes in the nominating ballot of the preceding year and of any other persons who were newly proposed for consideration at that time. Each member of the section shall be expected to return this ballot to the chairman within two weeks with his signature and with crosses placed against the names of those persons whom he is prepared to indorse for nomination. Each member may also write upon the ballot in a place provided for the purpose any new names which he desires to have included in the ballot to be submitted to the section in the following year. The vote resulting from this ballot shall be regarded as informal.

The chairman shall then submit to the members of his section a new ballot showing the results of the informal vote; and each member shall be expected to return this ballot to the chairman with his signature and with crosses placed against the names of those persons whom he will indorse for nomination.

The chairman shall then certify to the home secretary, prior to January 1, the names of those persons who have been voted for on this second ballot by a majority of the members of the section, and shall furnish him a list of the publications of these nominees, as required by the constitution.

A. A. NOYES, *Chairman.*

The recommendation of the committee was adopted by the academy as an amendment to Rule IV (p. 58, seq.).

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ELECTION OF MEMBERS OF THE COUNCIL.

Mr. W. H. Howell and Mr. J. M. Coulter were chosen members of the council to succeed Mr. W. T. Councilman and Mr. R. S. Woodward.

ELECTION OF NEW MEMBERS.

The following were elected members of the academy on April 21, 1915:

Henry Seely White, mathematician, Vassar College, Poughkeepsie, N. Y.

Charles Greeley Abbot, astrophysicist, Astrophysical Observatory, Smithsonian Institution, Washington, D. C.

Robert Andrews Millikan, physicist, University of Chicago, Chicago, Ill.

Alexander Smith, chemist, Columbia University, New York City.

Samuel Wendell Williston, paleontologist, University of Chicago, Chicago, Ill.

William Ernest Castle, zoologist, Harvard University, Cambridge, Mass.

Frank Rattray Lillie, zoologist, University of Chicago, Chicago, Ill.

Graham Lusk, physiologist, Cornell University Medical College, New York City.

Victor Clarence Vaughan, pathologist, University of Michigan, Ann Arbor, Mich.

Granville Stanley Hall, psychologist, Clark University, Worcester, Mass.

CONSTITUTION OF THE NATIONAL ACADEMY OF SCIENCES.

The draft of the constitution as amended and unanimously adopted in the committee of the whole at the Chicago meeting, printed in full on pages 30–37, Annual Report for 1914, was presented by the president as chairman of the committee of the whole, and adopted.

RULES.

The rules revised and arranged in groups to correspond with the articles and sections of the new constitution were presented and adopted as printed on pages 56–61 of this report.

ANNOUNCEMENTS OF COMMITTEE PERSONNEL.

The president announced the appointment of the following new members of standing committees:

The Henry Draper fund: J. S. Ames in place of A. W. Wright.

The J. Lawrence Smith fund: E. C. Pickering to succeed Raphael Pumpelly.

The Comstock fund: Elihu Thomson to succeed himself.

The Murray fund: W. H. Dall to succeed himself.

The Marcellus Hartley fund: George F. Becker, appointed chairman in place of Elihu Thomson, resigned; Theobald Smith to succeed Elihu Thomson, resigned.

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ANNOUNCEMENT OF THE AUTUMN MEETING.

The president announced that an invitation had been received from the members of the academy living in New York City asking that the autumn meeting be held there, and that this invitation had been accepted.

SCIENTIFIC SESSIONS.

The following program of scientific sessions was carried out in full at the annual meeting of the National Academy of Sciences, 1915:

PROGRAM, ANNUAL MEETING, APRIL 19, 20, 21, 1915.

Monday, April 19, 1915.

[2.30 p. m.—Auditorium, National Museum.]

Thomas H. Morgan: Localization of the hereditary material in germ cells. (30 minutes.)

PROBLEMS OF NUTRITION AND GROWTH.

Jacques Loeb: Stimulation of growth. (30 minutes.)

Lafayette B. Mendel: Specific chemical aspects of growth. (30 minutes.)

Eugene F. Du Bois, medical director, Russell Sage Institute of Pathology (by invitation of the program committee): Basal metabolism during the period of growth. (30 minutes.)

I. S. Kleiner and S. J. Meltzer: Retention in the circulation of injected dextrose in depancreatized animals and the effect of an intravenous injection of an emulsion of pancreas upon this retention. (10 minutes.)

[8 p. m.—Auditorium, National Museum.]

First William Ellery Hale lecture, by Thomas Chrowder Chamberlin, of the University of Chicago. Subject: The evolution of the earth. (Illustrated.)

The lecture will be followed by a conversazione in the art gallery of the Museum. All members of the scientific societies of Washington, with ladies, are cordially invited to attend both lecture and conversazione. No cards are necessary.

Tuesday, April 20, 1915.

[10 a. m.—Auditorium, National Museum.]

Joel Stebbins, Draper medallist: The electrical photometry of stars. (30 minutes. illustrated.)

George E. Hale: A vortex hypothesis of sun spots. (20 minutes, illsutrated.)

Edwin B. Frost: The spectroscopic binary, mu orionis. (10 minutes, illustrated.)

Robert W. Wood: One-dimensional gases and the experimental determination of the law of reflection for gas molecules. (10 minutes, illustrated.)

Robert W. Wood: The relations between resonance and absorption spectra. (15 minutes, illustrated.)

Edward L. Nichols and H. L. Howes: On the polarized fluorescence of ammonio-uranyl chloride. (15 minutes, illustrated.)

Robert A. Millikan (by invitation of the program committee): Atomism in modern physics. (30 minutes, illustrated.)

[2.30 p. m.—Auditorium, National Museum.]

William Morris Davis: Problems associated with the origin of coral reefs, suggested by a Shaler memorial study of the reefs of Fiji, New Caledonia, Loyalty Islands, New Hebrides, Queensland, and the Society Islands, in 1914. (60 minutes, illustrated.)

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F. W. Clarke: Inorganic constituents of marine invertebrates. (15 minutes.)

Roy L. Moody (introduced by H. F. Osborn): Amphibia and reptilia of the American Carboniferous. (15 minutes, illustrated.)

Henry Fairfield Osborn and J. Howard McGregor: Human races of the old stone age of Europe, the geologic time of their appearance, their racial and anatomical characters. (15 minutes, illustrated.)

Charles A. Davis, geologist, Bureau of Mines (by invitation of the program committee): On the fossil algæ of the petroleum-yielding shales of the Green River formation. (15 minutes, illustrated.)

Nathaniel L. Britton: The forests of Porto Rico. (10 minutes.)

J. Walter Fewkes: Pictures on prehistoric pottery from the Mimbres Valley in New Mexico and their relation to those of Casas Grandes. (20 minutes, illustrated.)

Charles B. Davenport: Inheritance of temperament. (15 minutes.)

Charles B. Davenport: Inheritance of Huntington's chorea. (12 minutes.)

E. E. Barnard: A singular dark marking on the sky. (5 minutes, illustrated.)

E. W. Brown (introduced by R. S. Woodward): Biographical memoir of George William Hill. (Read by title.)

Wednesday, April 21, 1915.

[2.45 p. m.—Auditorium, National Museum.]

George H. Parker, official representative of the academy upon the special commission appointed by the President of the United States to study and report upon the Alaskan fur seals during the summer of 1914. Subject: The fur-seal herd of the Pribilof Islands. (Illustrated.)

[4 p. m.—Auditorium, National Museum.]

Second William Ellery Hale lecture, by Thomas Chrowder Chamberlin, of the University of Chicago. Subject: The evolution of the earth. (Illustrated.)

PRESENTATION OF THE HENRY DRAPER MEDAL.

At the annual dinner of the Academy, held at the Hotel Raleigh April 20, 1915, the Henry Draper medal, provided by the Henry Draper fund, was awarded to Joel Stebbins, of the University of Illinois, in recognition of his work on application of the selenium cell to stellar photometry.

AUTUMN MEETING.

The autumn meeting of the academy was held in the American Museum of Natural History at New York City, on November 15, 16, 17, 1915. Forty-eight members were present, as follows: Abbot (C. G.), Becker, Boas, Boltwood, Britton, Castle, Cattell, Chittenden, Clark (W. B.), Clarke (F. W.), Clarke (J. M.), Conklin, Coulter, Crew, Cross, Davenport, Day, Donaldson, Hague, Harper, Harrison, Hillebrand, Holmes, Howell, Iddings, Lindgren, Loeb, Lusk, Mall, Mendel, Michelson, Morgan, Morse, Noyes (A. A.), Osborn (H. F.), Osborne (T. B.), Pickering, Ransome, Reid, Richards, Rosa, Schuchert, Smith (Theobald), Van Hise, Walcott, Webster, Wheeler, White, (H. S.).

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BUSINESS SESSION.

The home secretary made the following announcements:

DEATHS SINCE THE ANNUAL MEETING.

Members.—John Ulric Nef, elected 1904, died August 13, 1915; Frederick W. Putnam, elected 1885, died August 18, 1915.

Foreign associates.—Theodor Boveri, elected 1913, died October 15, 1915; Paul Ehrlich, elected 1904, died August 20, 1915.

PUBLICATIONS ISSUED SINCE THE LAST ANNUAL MEETING.

Proceedings, volume 1, numbers 1–11.

Memoirs, volume 12, part 2, memoirs 2 and 3, volume 13, as follows:

Volume 12, part II. Second memoir, Charles C. Adams: The variations and ecological distribution of the snails of the genus Io.

Third memoir, Joseph E. Pogue: The Turquois; a study of its history, mineralogy, geology, ethnology, archæology, mythology, folklore, and technology.

Volume 13, Oliver Cummings Farrington: Catalogue of the meteorites of North America to January 1, 1909.

Biographical memoirs: John Huntington Crane Coffin, by G. C. Comstock; Miers Fisher Longstreth, by Rebecca C. Longstreth; Charles Anthony Schott, by Cleveland Abbe; Henry Morton, by Edward L. Nichols; John Wesley Powell, by William M. Davis; Peter Lesley, by William M. Davis.

COMMITTEE CHANGES.

The election of Edwin B. Frost to be chairman of the board of directors of the Bache fund, and of Arthur Gordon Webster to succeed Ira Remsen as a member of the board.

The board is now constituted as follows:

E. B. Frost, chairman; A. G. Webster, R. G. Harrison.

The election of Theodore William Richards to succeed Ira Remsen as a member of the board of directors of the Wolcott Gibbs fund.

The board is now constituted as follows:

C. L. Jackson, chairman; T. W. Richards, Edgar F. Smith.

The ad interim appointments of acting chairmen of the sections of the academy are as follows:

Mathematics: E. H. Moore, acting chairman.

Astronomy: G. C. Comstock, acting chairman.

Physics and Engineering: R. S. Woodward, acting chairman.

Chemistry: A. A. Noyes, acting chairman.

Geology and Paleontology: Arnold Hague, acting chairman.

Botany: J. M. Coulter, chairman, 1915–1918.

Zoology and Animal Morphology: E. G. Conklin, acting chairman.

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The ad interim appointments of acting chairmen—Continued.

Physiology and Pathology: R. H. Chittenden, acting chairman.

Anthropology and Pscyhology: W. H. Holmes, acting chairman.

The following members were appointed a committee to audit the accounts of the treasurer in accordance with Rule V, 5: William H. Dall, chairman; Arthur L. Day, F. W. Clarke.

The division of the members of the editorial board of the Proceedings into three groups, one-third of them retiring annually, in accordance with Rule V, 1 was announced as follows:

December 1, 1916.—W. B. Cannon, J. McK. Cattell, J. M. Coulter, Simon Flexner, R. G. Harrison.

December 1, 1917.—C. B. Davenport, E. G. Conklin, E. B. Frost, W. H. Holmes, E. H. Moore.

December 1, 1918.—J. M. Clarke, J. J. Abel, R. A. Millikan, Alexander Smith, J. P. Iddings.

DELEGATES.

Mr. Arthur L. Day represented the National Academy at the inauguration of Dr. F. J. Goodnow as president of Johns Hopkins University and at the dedication of the new University buildings on March 20, 1915.

Mr. T. H. Morgan represented the National Academy at the fiftieth anniversary of Vassar College and the inauguration of Dr. H. N. MacCracken as president on October 13, 1915.

COMMITTEE ON PANAMA CANAL.

The president announced that in accordance with the request of the President of the United States he had appointed the following a committee of the academy to consider and report upon the possibility of controlling the slides which are seriously interfering with the use of the Panama Canal: C. R. Van Hise, chairman; H. L. Abbot, G. F. Becker, J. C. Branner, Whitman Cross, Arthur L. Day, J. F. Hayford, H. F. Reid, R. S. Woodward, R. C. Carpenter, Arthur P. Davis, John R. Freeman.

MARSH FUND.

The treasurer reported that Mr. W. W. Farnam, executor of the estate of O. C. Marsh, deceased, had transmitted to the academy on July 23, 1915, the final payment of $750, completing the legacy of $10,000 left by Mr. Marsh to the National Academy of Sciences.

CONSOLIDATION OF FUNDS.

The treasurer reported that the plan for the consolidation of certain funds of the academy for investment purposes had been approved by the fiscal advisers of the academy, Messrs. Spencer Trask

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& Co., of New York, and the American Security & Trust Co., of Washington, D. C., and that by direction of the council the contemplated consolidation of the investments would be completed about February 1, 1916.

REPORT OF THE COMMITTEE ON THE HENRY DRAPER FUND.

The committee on the Henry Draper fund recommends to the academy that the following appropriations be made from available income:

Four hundred dollars to Dr. Frank Schlesinger, director of the Allegheny observatory, to be applied toward the construction of a machine for measuring astronomical photographs.

Three hundred dollars to Dr. Joel Stebbins, director of the University of Illinois observatory, to be used in the further development of the photo-electric photometer and its application to the study of variable stars.

Two hundred dollars to be applied toward the expense of publishing the Proceedings of the National Academy.

GEORGE E. HALE,
Chairman.

NAME OF THE ACADEMY.

The following motion was approved by the academy:

That on the title page of the Proceedings and of other publications of the academy, where permissible, the legal title, National Academy of Sciences, be followed by the words "of the United States of America."

REPORT OF THE COMMITTEE ON THE MEDAL FOR EMINENCE IN THE APPLICATION OF SCIENCE TO THE PUBLIC WELFARE.

As no names of candidates were laid before the academy at the autumn meeting in 1914, the money available for making medals will be added to the principal of the Marcellus Hartley fund.

At the stated meeting in April Mr. Thomson expressed by letter a desire to be relieved, and I was appointed chairman.

The committee recommends to the academy that the medal for eminence in the application of science to the public welfare be conferred by the academy at its annual meeting in 1916 upon Mr. Cleveland Abbe and Mr. Gifford Pinchot.

In 1868 Mr. Cleveland Abbe was appointed director of the Cincinnati Observatory. On September 1, 1869, he inaugurated daily weather reports for the Cincinnati Chamber of Commerce. The favor with which the Cincinnati observations were received was brought to the attention of Congress, which passed a joint resolution in February, 1870, directing the Secretary of War to provide for weather observations. In January, 1871, Gen. Meyer was directed to take charge of the new weather bureau, and he appointed Abbe his meteorologist. In the first year Abbé in person did all the work of collating and tabulating. He remained in the Signal Service until 1891, when the United States Weather Bureau was inaugurated under the Department of Agriculture, and in this bureau he has served ever since. It is apparent that the weather service of the United States owes its origin and a very large part of its efficiency to Mr. Abbe. It is unnecessary to call attention to the fact that the warnings sent out by this service have saved great numbers of lives and vast sums of money. The attempts to predict the weather on scientific principles were at first met in Europe by ridicule, but most of the European countries have since established bureaus of the same description, all of which is due to Abbe.

As to the work of Mr. Gifford Pinchot, it is so recent and well known that a few words will suffice. Only a few years ago the tendency in the United States to squander

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its natural resources was lamentable. Mr. Pinchot's efforts brought about the reaction in favor of conservation, finding earnest support and sympathy from Mr. Roosevelt during his first presidential term.

Mr. Pinchot's efforts were at first confined to forest reserves, these being in his own charge, but his public and private warnings and arguments have led to greatly increased caution in the expenditure of the national capital.

GEORGE F. BECKER,
Chairman.

AWARD OF THE MEDAL FOR EMINENCE IN THE APPLICATION OF SCIENCE TO THE PUBLIC WELFARE.

Upon recommendation of the committee on the medal for eminence in the application of science to the public welfare and the indorsement of the council, the academy voted to award two medals at its annual meeting in 1916.

To Mr. Cleveland Abbe, member of the academy, for distinguished public service in establishing and organizing the Weather Service of the United States.

This is the first award of this medal to a member of the academy.

To Mr. Gifford Pinchot for distinguished public service in organizing and directing the movement for the systematic conservation of the natural resources of the United States.

REPORT OF THE EDITORIAL BOARD OF THE PROCEEDINGS.

The editorial board of the Proceedings presents the following brief report of the progress during the past year:

The first 10 issues of the Proceedings have consisted of 562 pages. In the numbers have been presented reports of the spring meeting, notices of the scientific and biographical memoirs published by the academy, and 141 original papers averaging very nearly four pages in length. These articles have been distributed among the different sciences as follows: Astronomy, 29; mathematics, 19; chemistry, 18; physiology, 16; genetics, 14; anthropology, 11; zoology, 10; physics, 7; botany, 4; geology, 4; psychology, 2; various other sciences, 1 or 2 each.

Two well-attended meetings of the editorial board have been held during the year, at which plans were discussed of increasing the number of contributions to the Proceedings, of enlarging their circulation, and of improving the character of the journal. A foreign mailing list, including 905 names, has been prepared by the foreign secretary, with the cooperation of the editors, and the Proceedings are being circulated in accordance with this list.

A statement from the treasurer shows that the cost of printing and distributing the first 10 numbers of the Proceedings has been $2,466.04, and that the other charges on the proceedings account from January 1, 1915, to November 9, 1915, have amounted to $1,188.30.

ARTHUR A. NOYES, *Chairman.*

NEW RULE REPLACING RULE IV, 1.

Upon recommendation of the council the following amendment to the rules of the academy was adopted:

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Rule IV, 1, to read:

"The term of service of each chairman of a section shall be three years, to date from the closing session of the April meeting next following his election. Chairmen of sections shall be chosen by mail ballot, the member receiving the highest number of votes cast to be deemed elected. It shall be the duty of each retiring chairman to conduct the election of his successor and to report the result of the election to the home secretary before the April meeting at which his term of service expires. Should any section fail to elect a chairman before November 1, the president is empowered to appoint a temporary chairman to serve until the April meeting next following. No chairman shall be eligible for reelection for two consecutive terms."

SCIENTIFIC SESSIONS.

Following is the program of the scientific sessions at the New York meeting:

AMERICAN MUSEUM OF NATURAL HISTORY.

Monday, November 15.

[8 p. m.—Auditorium, first floor.]

MICHAEL IDVORSKY PUPIN: The problem of aerial transmission.

Tuesday, November 16.

[10.30 a. m.—West Assembly Hall, first floor.]

EDWIN G. CONKLIN: Nature of cell polarity.

W. E. CASTLE: Is selection or mutation the more important agency in evolution?

A. E. VERRILL: Inheritance of clubbed feet through five known generations; inheritance of abnormal or defective thumbs through four known generations.

CHAS. B. DAVENPORT: Heredity of stature.

E. C. MACDOWELL (introduced by Chas. B. Davenport): Parental alcoholism and mental ability—a comparative study of habit formation.

JAMES B. MURPHY (introduced by Jacques Loeb): Rôle of the lymphocytes in resistance to cancer.

GRAHAM LUSK: The colorimeter as an interpreter of life processes.

T. B. OSBORNE and LAFAYETTE B. MENDEL: The resumption of growth after failure to grow.

W. H. HOWELL: Ultramicroscopic studies of the fibrin-gel.

C. WILLIAM BEEBE (introduced by Henry Fairfield Osborn): Origin of the flight of birds.

FRANK M. CHAPMAN (introduced by Henry Fairfield Osborn): Ornithological survey of the Andes and western coast of South America.

DOUGLAS HOUGHTON CAMPBELL: Treubia.

MARSHALL A. HOWE (introduced by N. L. Britton): Fossil calcareous algae from the Panama Canal Zone with reference to reef-building algae.

A. B. STOUT (introduced by N. L. Britton): Sterility in plants and its inheritance.

J. N. ROSE (introduced by N. L. Britton): Recent explorations in the cactus deserts of South America.

GEORGE H. SHULL (introduced by Chas. B. Davenport): Some factors affecting the inheritance ratios in shepherd's purse.

HERBERT M. RICHARDS (introduced by R. A. Harper): The respiratory ratio of cacti in relation to their acidity.

R. A. HARPER: Some studies in morphogenesis.

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[2.30 p. m.—West Assembly Hall, first floor.]

HERBERT S. JENNINGS: Can we observe organic evolution in progress?

JOHN M. COULTER: Orthogenesis in plants.

THEODORE W. RICHARDS: Investigations recently conducted in the Wolcott Gibbs Memorial Laboratory.

B. B. BOLTWOOD: The life of radium.

Wednesday, November 17.

[10.30 a. m.—West Assembly Hall, first floor.]

ALFRED G. MAYER and ROBERT S. WOODWARD (by title): The biography of Alfred Marshall Mayer.

C. G. ABBOT: The solar radiation and its variability.

A. G. WEBSTER: Experiments and theory of conical horns; instruments for measurements of sound; an instrument for finding the direction of a fog signal.

EDWARD C. PICKERING: The New Draper Catalogue.

HENRY NORRIS RUSSELL (introduced by Edward C. Pickering): On the albedo of the moon and planets.

GEORGE F. BECKER: A possible origin for some spiral nebulae.

L. A. BAUER (introduced by R. S. Woodward): Concomitant changes in the earth's magnetism and solar radiation.

FRED E. WRIGHT and J. C. HOSTETTER (introduced by Arthur L. Day): Experiments on the mean free path of gases; observations on Wood's one-dimensional gas.

JAMES KENDALL (introduced by Alexander Smith): The water correction in conductivity determinations.

HENRY FAIRFIELD OSBORN: Extremes of adaptation in carnivorous dinosaurs, tyrannosaurus and ornithomimus.

C. K. LEITH (introduced by C. R. Van Hise): The influence of certain minerals on the development of schists and gneisses.

W. M. DAVIS: Glacial sculpture of the Mission Range, Montana.

WALDEMAR LINDGREN: Crystallization of quartz veins.

E. W. HILGARD: A peculiar clay from near the City of Mexico.

GEORGE P. MERRILL (introduced by Arthur L. Day): The minor constituents of meteorites (by title).

DECEASED MEMBERS.

FREDERIC WARD PUTNAM.

The following minute on the life and services of Prof. Putnam was placed upon the records of the faculty of arts and sciences of Harvard University at the meeting of October 26, 1915:

Frederic Ward Putnam, son of Ebenezer and Elizabeth Appleton Putnam, was born in Salem, Mass., April 16, 1839, and died August 18, 1915. His ancestors on both sides were early immigrants from England, the first American ancestor being John Putnam, who settled in Salem in 1640. The father, grandfather, and great-grandfather of Prof. Putnam were all graduates of Harvard College, and the associations of his mother's family had been close with the institution from its beginning.

His early schooling was received in private schools and at home under his father's tuition. At an early age he showed great interest

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in natural history and had thoughts of devoting himself to scientific pursuits. Promised an appointment at West Point, however, he was preparing himself to adopt a military career when Louis Agassiz met him at the museum of the Essex Institute and, recognizing in him a keen student, persuaded him to take up natural history as his life work. His preparation for the military profession was accordingly abandoned, and he devoted himself at once to the study of birds, being made curator of ornithology in the Essex Institute in 1856. In the following year he was made assistant to Prof. Agassiz, and entering the Lawrence Scientific School received the degree of S. B. in 1862. For a number of years after this he continued his work in the study of animal life as curator of vertebrates at the Essex Institute, of ichthyology at the Boston Society of Natural History, and as assistant in the museum of comparative zoology at Harvard University. During these years he had also some experience in museum administration, as he was entrusted with the charge of the museum of the Essex Institute and of the museum of the East Indian Marine Society in Salem, and later was made director of the museum of the Peabody Academy of Science in the same city. In 1873 he was chosen to fill the important position of permanent secretary of the American Association for the Advancement of Science, an office which he held for 25 years. Prof. Putnam's connection with the association lasted through one of the most important periods in its life, and to his energy and administrative ability much of its success was due.

Although it was in the field of natural history that Prof. Putnam for many years carried on most of his work, his interest in archeology was early aroused. While attending the meeting of the American Association at Montreal in 1857 he discovered on Mount Royal a small kitchen-midden, and was thus among the very first in this country to recognize the presence of the remains of prehistoric man. In 1874 Dr. Jeffries Wyman, the first curator of the Peabody Museum of American Archeology and Ethnology, died, and Prof. Putnam was appointed to take the place. This began his connection with the institution of which he was the director for over 40 years. In 1886 he was made Peabody professor of American archeology and ethnology and served as such until 1909, when he joined the group of the emeriti. During the nearly half century of his connection with the museum he labored unceasingly to build up its collections, both by purchase and by explorations in the field. He was one of the earliest to realize the need of archeological and anthropological exploration and to insist that careful field notes and data are equally important with the specimens themselves. The great collections which he gathered and which place the museum in the forefront of the museums of this country are a witness of his success.

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With the appointment to the Peabody professorship, Harvard University became one of the first institutions in the country to offer instruction in the field of anthropology and American archeology. Although always more active in museum and field work than in teaching, Prof. Putnam strove constantly to develop the instruction in his chosen science from the time when, before any courses were offered, he had several voluntary students working under his direction, to the very last days of his life, when nearly a score of specialized courses were offered by the division of which he had for so long been the head.

Striking as were the results of his work here at Harvard, his influence was literally nation wide, and he may justly be called one of the fathers of anthropology in America, the others being Brinton, of Pennsylvania, and Powell, of Washington. In 1892 he was made chief of the department of anthropology at the World's Columbian Exposition at Chicago, and not only brought together what was probably the greatest archeological and anthropological exhibit ever gathered in this country up to that time, but collected by the aid of numerous collaborators a vast mass of data in regard to our native peoples which has not yet been fully worked up. The specimens so brought together for the exposition became the nucleus of the present Field Museum of Natural History, which may thus be regarded as, in its origins, of his making. In 1894 Prof. Putnam was made curator of anthropology in the American Museum of Natural History in New York City, and for nearly 10 years he applied to its administration and to the building up of its collections the experience he had gained in Cambridge and Chicago. It was again largely through his efforts that the University of California established a department of anthropology in 1903, and he held the position of professor of anthropology and director of the anthropological museum in that institution until his retirement in 1909.

In his long life of scientific work a great deal of Prof. Putnam's attention was necessarily devoted to administrative and editorial duties, but he found time, nevertheless, for the writing of a large number of scientific papers, and the bibliography appended to the anniversary volume presented to him in 1909 by his associates and students, contains something over 400 titles. His membership in scientific societies, both at home and abroad, was extensive. In this country he was a member of the National Academy of Sciences, the American Academy of Arts and Sciences, the American Philosophical Society, and a great many others; outside the United States he was an honorary or corresponding member of the anthropological societies of Great Britain, Paris, Stockholm, Berlin, Rome, Florence, and Brussels, of the Royal Society of Edinburgh, and others of minor

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importance. In 1868 he received the degree of A. M. from Williams College; in 1894 the degree of S. D. from the University of Pennsylvania; and in 1896 the Cross of the Legion of Honor from the French Government.

Prof. Putnam was twice married: In 1864 to Adelaide Martha Edmands, of Cambridge, by whom he had three children, two daughters and one son. After her death, 15 years later, he married in 1882 Ester Orne Clarke, of Chicago, who, with his three children, survives him.

To his students and associates Prof. Putnam endeared himself by his kindliness and sympathy. For every one he had a cordial greeting and a pleasant word. He was ready always to give unstintedly of his time, and so far as he was able, from his pocket, to anyone who asked his aid. He had the gift of inspiring those with whom he came in contact with enthusiasm for research, and to few is it given to have so wide an influence. Until the very last years the great majority of those in this country who were working in the anthropological field had been associated more or less closely with Prof. Putnam, either as students or colleagues in the various institutions of which he he had been a member. His loss, therefore, is widely felt, not only because he was an able administrator and the last of the three founders of anthropological study in this country but also because he had won the affections of so many as a teacher and a friend. (Extract from Science, n. s., vol. 42, p. 638.)

PAUL EHRLICH.

Paul Ehrlich was a genius of the first order. He was born in Strehlen, Germany, March 14, 1854, and died at Frankfort-on-the-Main August 20, 1915. While he was still a student of medicine, the problems presented by the affinity of lead for certain tissues attracted his attention. From speculating on the nature of this affinity, his interest grew to include protoplasmic affinities in general, and thus was determined the direction his genius should take.

Some of the notable results of his early investigations are discoveries in bacterial staining methods, which proved of great value to Koch and which, ever since, have been in daily use everywhere; the microchemical differentiation of leukocytes, on which rests the study of the blood for clinical purposes; the development of the methylene blue reaction on living tissues, and the formulation of that unique conception of protoplasmic structure and function on which he based the great side-chain theory which he advanced to explain the reactions in immunity and other phenomena.

What might be termed the second phase of Ehrlich's work concerned investigations in immunity under the guidance of the side-

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chain conception. No better illustration of the practical usefulness of the imagination in creating a successful working hypothesis can be given than the results achieved by Ehrlich in the field of immunity. Perhaps the usefulness is seen most clearly in the standardization of diphtheria antitoxin, which was a direct outcome of experiments devised according to the side-chain idea. Ehrlich's method, to the exclusion of others, is used all over the world; but the influence of the work carried out to his pupils still dominates investigation in all branches of immunity and the practical use of the knowledge obtained therefrom.

The side-chain theory is so well known that it is not necessary to restate it except in the most succinct form. A toxin or other antigen is without action on the animal body unless bound by molecular chains in the cells—receptors. But when so bound, the antigen causes injury to the cell, and subsequent repair, in the course of which there is an overproduction of receptors, which, passing into the blood and lymph, constitute the antibody for the antigen in question, because the antigen is now bound and neutralized or destroyed before it can reach the cell. As expressed by Behring, antibodies are free cell receptors, and the elements which, when situated in the cells, are essential for the action of toxins, for instance, are also the means of healing when free in the blood. In accord with the principles of this theory, Ehrlich's vivid mind coined numerous new words, which proved helpful in the discussion of new facts and ideas, and which soon passed into current international usage.

Ehrlich's last work was the development of the experimental chemotherapy of syphilis and certain other spirochetal infections. To discuss this wonderful work fully in all its ramifications is not possible at this time. The scientific world has accepted "the development through a lengthy series of systematic biochemical experiments, based on original conceptions of the affinities of cellular constituents, of a successful chemotherapy of important human infections, by direct attack on the parasites by substances specially built up for that purpose and introduced from without," as the fitting culmination of the tireless activities of an altogether unique investigative spirit. As pointed out elsewhere, Ehrlich's results in experimental chemotherapy fully justify Huxley's prediction in 1881 that through discoveries in therapeutics it would become possible "to introduce into the economy a molecular mechanism which, like a cunningly contrived torpedo, shall find its way to some particular group of living elements and cause an explosion among them, leaving the rest untouched.

Paul Ehrlich will live in the history of civilization as one of the great investigators, genial, creative, fertile, excelling in "that bold-

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ness of the scientific use of the imagination which alone can extend beyond the obvious fact and reveal the unknown," one of the great benefactors of mankind.

He was elected a foreign associate of the National Academy of Sciences in 1904.

(Extract from Science, n. s., vol. 42, p. 332.)

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ANNUAL REPORT OF THE TREASURER.

JANUARY 1 TO DECEMBER 31, 1915.

To the PRESIDENT OF THE NATIONAL ACADEMY OF SCIENCES:

SIR: I have the honor to submit the following report as treasurer for the fiscal year, January 1 to December 31, 1915. Before presenting the detailed statements of the report, some special features of the financial transactions of the year will be mentioned:

The income of the academy during the year, from dues, investments, subscriptions to Proceedings, contributions to the Proceedings fund and William Ellery Hale lectureship, was $15,685.03; the expenditures, exclusive of investments, amounted to $9,115.34.

The sum of investments held by the academy on December 31 was $228,071.85 (price paid), yielding on that date at the rate of 4.98 per cent. The total income from investments received during the year was $11,476.31.

Changes in investments may be summarized as follows: Eight first-mortgage notes on real estate, amounting to $8,000, were paid in full, one was curtailed by the payment of $1,000, and one bond of $1,000 was called and paid; bonds were purchased to the amount of $8,307.50 (face value, $8,500).

The academy has now received the full amount of $10,000, bequeathed to it by the late O. C. Marsh, the final payment of $750 having been received during the year.

The special fund contributed by members and friends of the academy toward the expenses of the publication of the Proceedings amounts to $1,148.70.

Payments made on grants from various funds, in aid of research and for medals, amounted to $6,915.56.

TRUST FUNDS OF THE ACADEMY.

The trust funds of the academy, the income of which is administered for specific purposes, are enumerated below. The capital of certain funds has been increased beyond the amount of the original gift or bequest, by the transfer of accumulated income, at the request of the donors or by action of the academy.

Bache fund: Bequest of Alexander Dallas Bache, a member of the academy, 1870. To aid researches in physical and natural sciences..... $56,000.00

Watson fund: Bequest of James C. Watson, a member of the academy, 1874. For the promotion of astronomical science through the award of the Watson gold medal and grants of money in aid of research..... 25,000.00

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Draper fund: Gift of Mrs. Henry Draper, 1883, in memory of her husband, a former member of the academy. To found the Henry Draper gold medal, to be awarded for notable investigations in astronomical physics. The balance of income is applied to aid research in the same science.... $10,000.00

Smith fund: Gift of Mrs. J. Lawrence Smith, 1884, in memory of her husband, a former member of the academy. To found the J. Lawrence Smith gold medal, to be awarded for important investigations of meteoric bodies and to assist, by grants of money, researches concerning such objects..... 10,000.00

Gibbs fund: Established by a gift of Wolcott Gibbs, a member of the academy, 1892, and increased by a bequest of the late Morris Loeb, 1914. For the promotion of researches in chemistry 5,500.00

Gould fund: Gift of Miss Alice Bache Gould, 1897, in memory of her father, a former member of the academy. For the promotion of researches in astronomy..... 20,000.00

Comstock fund: Gift of Gen. Cyrus B. Comstock, a member of the academy, 1907. To promote researches in electricity, magnetism or radiant energy, through the Comstock prize, of money, to be awarded once in five years for notable investigations. The fund is to be increased ultimately to $15,000..... 11,337.50

Marsh fund: Bequest of Othniel Charles Marsh, a member of the academy, 1909. To promote original research in the natural sciences..... 10,127.65

Murray fund: A gift from Sir John Murray, 1911, to found the Alexander Agassiz gold medal, in honor of a former member and president of the academy, to be awarded for original contributions to the science of oceanography..... 6,000.00

Hartley fund: A gift from Mrs. Helen Hartley Jenkins, 1913–14, in memory of her father, Marcellus Hartley, to found the medal of the academy awarded for eminence in the application of science to the public welfare..... 1,168.00

The sum of $1,168 is the balance of the original gift left after defraying all expenses of the first award of this medal. By action of the academy, the fund will be increased to $1,200 from accumulated income.

In addition to the above-named trust funds the academy holds the following:

Agassiz fund: Bequest of Alexander Agassiz, a member of the academy, 1910, for the general uses of the academy..... $50,000.00

Building fund: A gift from Alexander Agassiz and Theodore N. Gill, former members of the academy, together with accumulated income, toward a building for the academy..... 8,957.02

CONDENSED STATEMENT OF RECEIPTS AND EXPENDITURES, 1915.

RECEIPTS.

Balance, Jan. 1, 1915, as per last report.....	$11,281.00
Total income from investments during 1915.....	11,476.31
Annual dues:	
1913.....	5.00
1914.....	30.00
1915.....	645.00
Interest on bank deposits.....	211.80
William Ellery Hale lectureship	1,000.00

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Refund from general fund to Hale lectureship	$95.62
Return from Hale lectureship to general fund	495.62
Contributions to Proceedings	1,990.00
Subscriptions to Proceedings	538.72
Reprints and separate numbers of Proceedings	376.81
Addition to Marcellus Hartley fund	75.00
Mortgage notes paid	9,000.00
Bond called in	1,000.00
Return from Murray fund to general fund	300.00
Return unexpended balance B. O. Peirce grant, No. 175, to Bache fund	325.03
Balance of bequest from estate of O. C. Marsh	750.00
	39,595.91

EXPENDITURES.

Investment of capital		6,852.50
Investment of income		1,455.00
Accrued interest, account changes of investments		110.36
Payments from trust and other special funds:		
Bache fund—		
R. W. Hegner	$159.96	
J. Voûte	401.00	
H. H. Lane	500.00	
E. J. Werber	230.00	
H. S. Jennings	200.00	
H. W. Norris	100.00	
P. W. Bridgman	500.00	
Draper fund—		
Joel Stebbins (medal)	214.60	
W. W. Campbell	500.00	
S. A. Mitchell	250.00	
Frank Schlesinger	400.00	
Gibbs fund—		
Mary E. Holmes	100.00	
Gould fund—		
Astronomical Journal	1,000.00	
R. W. Wood	200.00	
A. Van Maanen	100.00	
Hale lectureship—		
T. C. Chamberlin honorarium	300.00	
Return to general fund	495.62	
M. Hartley fund—		
Balance on dies and two medals	432.00	
Murray fund—		
Agassiz medal—Return to general fund	300.00	
Smith fund—		
S. A. Mitchell	500.00	
Watson fund—		
A. O. Leuschner	480.00	
J. E. Mellish	300.00	
John A. Miller	380.00	
Mrs. A. H. Watson	100.00	
		8,143.18

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General expenses:		
Bache fund—		
Printing blank applications	$8.75	
Proceedings—		
Salary, managing editor	750.00	
Printing and distributing	2,977.37	
Expenses, office of editor	315.70	
Miscellaneous expenses	257.60	
General fund—		
Salary, assistant secretary and treasurer	600.00	
Treasurer's office (auditing, bond, printing, etc.)	125.00	
Home secretary's office (clerical help, printing constitution, lists of members, circulars, etc.)	688.10	
Foreign secretary's office	66.01	
Memoirs, printing, etc	1,266.84	
Refund to Hale lectureship fund	95.62	
Meetings—		
Annual meeting, lunches, etc	639.33	
Postage and telegrams	61.75	
Election of members (printing diplomas, etc.)	35.65	
		$7,887.72
Cash balance in bank, Dec. 31, 1915:[1]		
Cash income balance		12,228.35
Uninvested capital		2,918.80
		39,595.91

Unpaid dues: 1914, $10; 1915, $70; total, $80.

STATEMENTS OF ASSETS AND LIABILITIES, DECEMBER 31, 1915.

ASSETS.

1. Mortgage notes, secured by first mortgages on real estate		$105,750.00
2. Bonds, giving name, face value, rate of interest, and cost:		
12 Broadway Realty Co. first, 5 per cent gold, due Sept. 1, 1926. Purchase money. 12 at $1,000. Nos. 38, 50, 796, 963–5, 1068, 1616–20	$12,335.00	
10 Bush Terminal Building Co. first-mortgage 50-year sinking fund, 5 per cent gold bonds, due Apr. 1, 1960. 10 at $1,000. Nos. 1383–7 and 2805–9	9,850.00	
5 Chesapeake & Ohio general mortgage, 4.5's, gold bonds, due Mar. 1, 1992. 5 at $1,000. Nos. 15350, 15351, 15352, 15353, 15354	4,556.25	
4 City of Tacoma Green River special water fund No. 2, 5 per cent, due Oct. 1, 1939. 4 at $1,000, Nos. 1508, 1509, 1510, 1511	4,150.60	
7 Cleveland Electric & Illuminating Co. first-mortgage 5 per cent gold bonds, due Apr. 1, 1939. 4 at $500 and 3 at $1,000 each. Nos. M6060, M6096, M6097, D261, D262, D263, D264	5,100.00	
20 Cosmos Club 4.5 per cent bonds, due July 1, 1949. 20 at $1,000. Nos. 286–299, 301–305, 350	20,000.00	
7 Detroit Edison Co. 5's, first mortgage, 30-year gold, due Jan. 1, 1933. 7 at $1,000. Nos. 557, 2442, 2443, 3024, 3252, 3253, 8086	7,180.00	

[1] Two outstanding checks, $63.33.

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2. Bonds, etc.—Continued.		
5 Dominion Coal Co. (Ltd.) first-mortgage sinking-fund gold bonds, 5 per cent, due May 1, 1940. 5 at $1,000. Nos. A1036–A1040	$5,000.00	
2 Georgia Railway & Electric Co. first consolidated mortgage, 5's, sinking fund, gold, due Jan. 1, 1932. 2 at $1,000. Nos. 1061, 1600	2,060.00	
13 Government of the Province of Alberta bonds, 4.5 per cent, 10-year gold debenture, due Dec. 1, 1923. 2 at $500 and 11 at $100. Nos. 2031 and 2032, 1501–1511	2,021.25	
6 Government of the Province of Alberta bonds, 5 per cent, 10-year gold debenture, due May 1, 1925. 1 at $1,000 and 5 at $500. Nos. 2364, B189–B195.	3,395.00	
1 Government of the Province of Alberta bond, 4.5 per cent, 10-year gold debenture, due Feb. 1, 1924. 1 at $500. No. 2620	481.25	
6 Milwaukee Railway & Electric Light Co. general and refunding mortgage gold bond, series A, 5 per cent, due Dec. 1, 1951. 6 at $1,000. Nos. 2772, 5222, 5223, 5224, 3839, 3840	5,480.00	
6 Minneapolis General Electric Co. 5 per cent 30-year gold mortgage bonds, due Dec. 1, 1934. 6 at $1,000. Nos. 1621, 1622, 1949, 2004, 7579, 7580	6,080.00	
4 Niagara Falls Power Co. first mortgage, 5's, gold coupon bonds, due Jan. 1, 1932. 4 at $1,000. Nos. 5246, 5247, 6583, 8358	4,100.00	
20 Riggs Realty Co. 3/30-year coupon bond, first, 5's, due Oct. 1, 1940. 20 at $1,000. Nos. 56, 60, 76, 80, etc., to 144	20,705.00	
9 Southern Bell Telephone & Telegraph Co. 30-year, first mortgage, 5's, sinking fund, gold bonds. Due Jan. 1, 1941. 9 at $1,000. Nos. M9739 M11576, M11577, M11578, M11579, M13965, M15568, M15569, M15570	8,817.50	
1 Union Electric Light & Power Co. of St. Louis, first, 5's, due Sept. 1, 1932. 1 at $1,000. No. 4169.	1,010.00	
		$122,321.85
3. Bank balance, Dec. 31, 1915 [1]		15,147.15
		243,219.00

LIABILITIES.

	Income.	Capital.
General fund:		
Invested	$4,700.00	.....
Uninvested	2,139.95	.....
Agassiz fund:		
Invested		$49,900.00
Uninvested		100.00
Bache fund:		
Invested	2,575.00	55,917.95
Uninvested	3,832.57	82.05

[1] Two outstanding checks, $63.13.

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	Income.	Capital.
Building fund:		
Invested	$1,562.50	$5,490.00
Uninvested	391.53	1,510.00
Comstock fund:		
Invested	677.50	11,315.00
Uninvested	708.82	22.50
Draper fund:		
Invested	1,035.00	10,000.00
Uninvested	1,247.06	.....
Gibbs fund:		
Invested	.....	5,457.50
Uninvested	345.77	42.50
Gould fund:		
Invested	4,057.50	19,953.75
Uninvested	859.65	46.25
Marsh fund:		
Invested	677.50	9,377.65
Uninvested	271.88	750.00
Murray fund:		
Invested	.....	5,965.00
Uninvested	.....	35.00
Smith fund:		
Invested	1,532.50	9,895.00
Uninvested	762.27	105.00
Watson fund:		
Invested	1,020.00	24,922.50
Uninvested	92.65	77.50
Marcellus Hartley fund:		
Invested	.....	1,020.00
Uninvested	147.50	148.00
William Ellery Hale lectureship:		
Invested	.....	.....
Uninvested	300.00	.....
Proceedings:		
Invested	1,020.00	.....
Uninvested	1,128.70	.....
Total	31,085.85	212,133.15
		31,085.85
		243,219.00

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ACCOUNT WITH INDIVIDUAL FUNDS JAN. 1 TO DEC. 31, 1915.

	General fund.		Building fund.	
	Income.	Capital.	Income.	Capital.
Balance Jan. 1, 1915:				
Cash	$1,416.65		$437.53	$10.00
Invested	5,200.00		1,077.50	6,990.00
Receipts:				
Interest on investments	2,759.18		441.99	
Interest on deposits	211.80			
Murray fund return	300.00			
Annual dues—				
1913	5.00			
1914	30.00			
Hale lectureship return	495.62			
Total	10,418.25		1,957.02	7,000.00
Disbursements:				
General expenses	3,482.68			
Hale lectureship refund	95.62			
Accrued interest			2.99	
Balance Dec. 31, 1915:				
Cash	2,139.95		391.53	1,510.00
Invested	4,700.00		1,562.50	5,490.00
Total	10,418.25		1,957.02	7,000.00
Mortgage paid	500.00			1,500.00
Investment made			485.00	

	Agassiz fund.		Bache fund.	
	Income.	Capital.	Income.	Capital.
Balance Jan. 1, 1915:				
Cash		$100.00	$2,552.81	$67.05
Invested		49,900.00	2,575.00	55,932.95
Receipts:				
Interest on investments			3,057.43	
Return estate of B. O. Peirce			325.03	
Total		50,000.00	8,510.27	56,000.00
Disbursements:				
Warrants			2,090.96	
General expenses			8.75	
Accrued interest			2.99	
Balance Dec. 31, 1915:				
Cash		100.00	3,832.57	82.05
Invested		49,900.00	2,575.00	55,917.95
Total		50,000.00	8,510.27	56,000.00
Mortgage paid				500.00
Investment made				485.00

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Account with individual funds Jan. 1 to Dec. 31, 1915—Continued.

	Comstock fund.		Draper fund.	
	Income.	Capital.	Income.	Capital.
Balance Jan. 1, 1915:				
Cash	$620.81	$22.50	$1,018.33	.....
Invested	192.50	11,315.00	2,035.00	$10,000.00
Receipts:				
Interest on investments	576.00	.....	593.33	.....
Total	1,389.31	11,337.50	3,646.66	10,000.00
Disbursements:				
Warrants	.....	.....	1,150.00	.....
Medal	.....	.....	214.60	.....
Accrued interest	2.99	.....	.....	.....
Balance Dec. 31, 1915:				
Cash	708.82	22.50	1,247.06	.....
Invested	677.50	11,315.00	1,035.00	10,000.00
Total	1,389.31	11,337.50	3,646.66	10,000.00
Mortgage paid	.....	.....	1,000.00	.....
Investment made	485.00	.....	.....	.....

	Gibbs fund.		Gould fund.	
	Income.	Capital.	Income.	Capital.
Balance Jan. 1, 1915:				
Cash	$164.49	$27.50	$1,062.14	$18.75
Invested	.....	5,472.50	4,057.50	19,981.25
Receipts:				
Interest on investments	284.27	.....	1,186.11	.....
Total	448.76	5,500.00	6,305.75	20,000.00
Disbursements:				
Warrants	100.00	.....	1,300.00	.....
Accrued interest	2.99	.....	88.60	.....
Balance Dec. 31, 1915:				
Cash	345.77	42.50	859.65	46.25
Invested	.....	5,457.50	4,057.50	19,953.75
Total	448.76	5,500.00	6,305.75	20,000.00
Mortgages paid	.....	500.00	.....	5,000.00
Investments made	.....	485.00	.....	4,972.50

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Account with individual funds Jan. 1 to Dec. 31, 1915—Continued.

	Marsh fund.		Murray fund.	
	Income.	Capital.	Income.	Capital.
Balance Jan. 1, 1915:				
Cash	$425.87			$35.00
Invested	192.50	$9,377.65		5,965.00
Receipts:				
Interest on investments	334.00		$300.00	
Estate of O. C. Marsh		750.00		
Total	952.37	10,127.65	300.00	6,000.00
Disbursements:				
Return to general fund			300.00	
Accrued interest	2.99			
Balance Dec. 31, 1915:				
Cash	271.88	750.00		35.00
Invested	677.50	9,377.65		5,965.00
Total	952.37	10,127.65	300.00	6,000.00
Investment made	485.00			

	Smith fund.		Watson fund.	
	Income.	Capital.	Income.	Capital.
Balance Jan. 1, 1915:				
Cash	$696.58	$15.00	$81.15	$77.50
Invested	1,532.50	9,985.00	1,020.00	24,922.50
Receipts:				
Interest on investments	572.50		1,271.50	
Total	2,801.58	10,000.00	2,372.65	25,000.00
Disbursements:				
Warrants	500.00		1,260.00	
Accrued interest	6.81			
Balance Dec. 31, 1915:				
Cash	762.27	105.00	92.65	77.50
Invested	1,532.50	9,895.00	1,020.00	24,922.50
Total	2,801.58	10,000.00	2,372.65	25,000.00
Bond paid		1,000.00		
Investment made		910.00		

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Account with individual funds Jan. 1 to Dec. 31, 1915—Continued.

	Proceedings.		Hale lectureship.	
	Income.	Capital.	Income.	Capital.
Balance, Jan. 1, 1915:				
Cash	$1,828.84			
Invested	1,020.00			
Receipts:				
Interest on investments	50.00			
Contribution to Hale lectureship			$1,000.00	
Reprints and separate numbers	376.81			
Contribution to Proceedings	1,990.00			
Subscriptions, 1915	494.22			
Subscriptions, 1916	44.50			
Annual dues, 1915	645.00			
Hale lectureship refund			95.62	
Total	6,449.37		1,095.62	
Disbursements:				
General expenses	4,300.67			
Return to General fund			495.62	
Honorariums			300.00	
Balance, Dec. 31, 1915:				
Cash	1,128.70		300.00	
Invested	1,020.00			
Total	6,449.37		1,095.62	

	Hartley fund.	
	Income.	Capital.
Balance, Jan. 1, 1915:		
Cash	$22.50	$580.00
Invested		1,020.00
Receipts:		
Interest on investments	50.00	
Contribution to public welfare medal	75.00	
Total	147.50	1,600.00
Disbursements:		
General expenses		432.00
Balance, Dec. 31, 1915:		
Cash	147.50	148.00
Invested		1,020.00
Total	147.50	1,600.00

WHITMAN CROSS,
Treasurer.

JANUARY 5, 1916.

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REPORT OF THE AUDITING COMMITTEE.

WASHINGTON, D. C., *January 14, 1916.*

We hereby certify that we have examined the securities and papers contained in the box of the National Academy of Sciences at the American Security & Trust Co.'s building and have found them to correspond with the list checked by the auditing committee on January 15, 1915.

We find that the coupons due in 1915 have been cut and are accounted for; also that the coupons due January 1, 1916, have been detached and are accounted for by an appropriate entry in the pass book. We have accepted the certified statement of the Capital Audit Co. as to the correspondence between the vouchers, pass book, and accounts of the treasurer and as to the balance shown by the books of the treasurer on December 31, 1915, and certify to its agreement with the balance shown by the report of the treasurer, by his check book and by the American Security & Trust Co.

W. H. DALL.
F. W. CLARKE.

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APPENDICES.

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APPENDIX A.

CONSTITUTION OF THE NATIONAL ACADEMY.

As amended and adopted April 17, 1872, and further amended April 20, 1875; April 21, 1881; April 19, 1882; April 18, 1883; April 19, 1888; April 18, 1895; April 20, 1899; April 17, 1902; April 18, 1906; November 20, 1906; April 17, 1907; November 20, 1907; April 20, 1911; April 16, 1912; April 21, 1915.

PREAMBLE.

Empowered by the act of incorporation enacted by Congress, and approved by the President of the United States on the 3d day of March, A. D. 1863, and in conformity with amendments to said act approved July 14, 1870, June 20, 1884, and May 27, 1914, the National Academy of Sciences adopts the following amended constitution and rules:

ARTICLE I.—OF MEMBERS.

SECTION 1. The academy shall consist of members, honorary members, and foreign associates. Members must be citizens of the United States.

SEC. 2. Members who, from age or inability to attend the meetings of the academy, wish to resign the duties of active membership, may, at their own request, be transferred to the roll of honorary members by a vote of the academy.

SEC. 3. The academy may elect 50 foreign associates.

SEC. 4. Honorary members and foreign associates shall have the privilege of attending the meetings and of reading and communicating papers to the academy, but shall take no part in its business, shall not be subject to its assessments, and shall be entitled to a copy of the publications of the academy.

ARTICLE II.—OF THE OFFICERS.

SECTION 1. The officers of the academy shall be a president, a vice president, a foreign secretary, a home secretary, and a treasurer, all of whom shall be elected for a term of six years, by a majority of votes present, at the first stated meeting after the expiration of the current terms, provided that existing officers retain their places until their successors are elected. In case of a vacancy, the election for six years shall be held in the same manner at the meeting when such vacancy occurs, or at the next stated meeting thereafter, as the academy may direct. A vacancy in the office of treasurer or home

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secretary may, however, be filled by appointment of the president of the academy until the next stated meeting of the academy.

SEC. 2. The officers of the academy, together with six members to be elected by the academy, shall constitute a council for the transaction of such business as may be assigned to them by the constitution or the academy.

SEC. 3. The president of the academy, or, in case of his absence or inability to act, the vice president, shall preside at the meetings of the academy and of the council; shall name all committees except such as are otherwise especially provided for; shall refer investigations required by the Government of the United States to members especially conversant with the subjects and report thereon to the academy at its meeting next ensuing; and, with the council, shall direct the general business of the academy.

It shall be competent for the president, in special cases, to call in the aid, upon committees, of experts or men of special attainments not members of the academy.

The president shall be, *ex officio*, a member of all committees empowered to consider questions referred to the academy by the Government of the United States.

SEC. 4. The foreign and home secretaries shall conduct the correspondence proper to their respective departments, advising with the president and council in cases of doubt, and reporting their action to the academy at one of the stated meetings in each year.

It shall be the duty of the home secretary to give notice to the members of the place and time of all meetings, of all nominations for membership, and of all proposed amendments to the constitution.

It shall be the duty of the home secretary to keep the minutes of each business and scientific session, and after approval to enter these upon the permanent records of the academy.

SEC. 5. The treasurer shall attend to all receipts and disbursements of the academy, giving such bond and furnishing such vouchers as the council may require. He shall collect all dues, assessments, and subscriptions, and keep a set of books showing a full account of receipts and disbursements and the condition of all funds of the academy. He shall be the custodian of the corporate seal of the academy.

ARTICLE III.—OF THE MEETINGS.

SECTION 1. The academy shall hold one stated meeting in each year, called the annual meeting, in the city of Washington, beginning on the third Monday in April, and another, called the autumn meeting, to be held at such place and time as the council shall determine.

Special business meetings of the academy may be called, by order of eight members of the council, at such place and time as may be designated in the call.

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Special scientific meetings of the academy may be held at times and places to be designated by a majority of the council.

SEC. 2. The names of the members present at each session of a meeting shall be recorded in the minutes, and the members present at any session shall constitute a quorum for the transaction of business.

SEC. 3. Scientific sessions of the academy, unless otherwise ordered by a majority of the members present, shall be open to the public; sessions for the transaction of business shall be closed.

SEC. 4. Stated meetings of the council shall be held during the stated or special meetings of the academy and four members shall constitute a quorum for the transaction of business. Special meetings of the council may be convened at the call of the president and two members of the council, or of four members of the council.

SEC. 5. No member whose dues are in arrears shall vote at any business meeting of the academy.

ARTICLE IV.—OF ELECTIONS AND RESIGNATIONS.

SECTION 1. All elections of officers and members shall be by ballot, and each election shall be held separately.

SEC. 2. The time for holding an election of officers shall be fixed by the academy at least one day before the election is held.

SEC. 3. The election of the six members of the council shall be as follows:

At the annual meeting in April, 1907, six members of the council to be elected, of whom two shall serve for three years, two for two years, and two for one year, their respective terms to be determined by lot. Each year thereafter the terms of two members shall expire, and their successors, to serve for three years, shall be elected at the annual meeting in each year.

SEC. 4. The academy shall be divided by the council into sections representing the principal branches of scientific research. Each section shall elect its own chairman, who shall serve for three years. The chairman shall be responsible to the academy for the work of his section.

Nominations to membership in the academy shall be made in writing and approved by a majority of the members of the section on the branch of research in which the person nominated is eminent, or by a majority of the council in case there is no section on the subject. The nominations shall be sent to the home secretary by the chairman of the section before January 1 of the year in which the election is to be held, and each nomination shall be accompanied by a list of the principal contributions of the nominee to science. This list shall be printed by the home secretary for distribution among the members of the academy.

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SEC. 5. Election of members shall be held at the annual meeting in Washington in the following manner: There shall be two ballots—a preference ballot, which may be prepared either before or at the annual meeting and must be transmitted to the home secretary, and a final ballot, to be taken at the meeting.

Preference ballot.—Each member may inscribe on a ballot not more than 15 names of nominees selected from the submitted list. A list of the nominees shall then be prepared, on which the names shall be entered in the order of the number of votes received by each. In case two or more nominees have the same number of votes on this preference list, the order in which they shall be placed on the list shall be determined by a majority vote of members present.

Final ballot.—A vote shall first be taken on the nominee who appears first on the preference list, and he shall be declared elected if he receive two-thirds of the votes cast and not less than 25 votes in all. A vote shall then be taken in similar manner on the nominee standing second on the preference list, and so on until all the nominees on the preference list shall have been acted on, or until 15 nominees shall have been elected or until the total membership of the academy shall have reached 250.

Not more than 15 members shall be elected at one annual meeting.

Before and during elections a discussion of the merits of nominees will be in order.

The election of members may be suspended at any time by a majority vote of the members present.

SEC. 6. Every member-elect shall accept his membership, personally or in writing, before the close of the next stated meeting after the date of his election. Otherwise, on proof that the secretary has formally notified him of his election, his name shall not be entered on the roll of members.

SEC. 7. Foreign associates may be nominated by the council and may be elected at the annual meeting by a two-thirds vote of the members present.

SEC. 8. A diploma, with the corporate seal of the academy and the signatures of the officers, shall be sent by the appropriate secretary to each member on his acceptance of membership, and to foreign associates on their election.

SEC. 9. Resignations shall be addressed to the president and acted on by the academy.

SEC. 10. Whenever a member has not paid his dues for four successive years, the treasurer shall report the fact to the council, which may report the case to the academy with the recommendation that the person thus in arrears be declared to have forfeited his membership. If this recommendation be approved by two-thirds of the members present, the said person shall no longer be a member of the academy and his name shall be dropped from the roll.

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ARTICLE V.—SCIENTIFIC COMMUNICATIONS, PUBLICATIONS, AND REPORTS.

SECTION 1. Communications on scientific subjects shall be read at scientific sessions of the academy, and papers by any member may be read by the author or by any other member, notice of the same having been previously given to the secretary.

SEC. 2. Any member of the academy may read a paper from a person who is not a member, and shall not be considered responsible for the facts or opinions expressed by the author, but shall be held responsible for the propriety of the paper.

Persons who are not members may read papers on invitation of the council or of the committee of arrangements.

SEC. 3. The academy may provide for the publication, under the direction of the council, of proceedings, scientific memoirs, biographical memoirs, and reports.

The proceedings shall include the transactions of the academy, brief original announcements of the results of scientific investigations made by members of the academy or others, together with short original articles giving a comprehensive survey of the more important scientific researches currently made by American investigators, and other matters of general scientific interest.

The scientific memoirs shall provide opportunity for the publication of longer and more detailed scientific investigations.

The biographical memoirs shall contain an appropriate record of the life and work of deceased members of the academy.

An annual report shall be presented to Congress by the president, and shall contain the annual reports of the treasurer and the auditing committee, a suitable summary of the reports of the committees in charge of trust funds, and a record of the activities of the academy for the calendar year immediately preceding and other appropriate matter. This report shall be presented to Congress by the president after authorization by the council. It shall also be presented to the academy at the annual meeting next following.

The treasurer shall prepare a full report of the financial affairs of the academy at the end of the fiscal year. This report shall be submitted to the council for approval and afterwards presented to the academy at the annual meeting.

SEC. 4. Propositions for investigations or reports by the academy shall be submitted to the council for approval, except those requested by the Government of the United States, which shall be acted on by the president, who will in such cases report their results to the Government as soon as obtained and to the academy at its next following stated meeting.

SEC. 5. The advice of the academy shall be at all times at the disposition of the Government upon any matter of science or art within its scope.

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ARTICLE VI.—OF THE PROPERTY OF THE ACADEMY.

SECTION 1. All investments and reinvestments of either principal or accumulations of income of the trust and other funds of the academy shall be made by the treasurer, with the approval of the finance committee, in the corporate name of the academy, in the manner and in the securities designated or specified in the instruments creating the several funds, or, in the absence of such designation or specification, in bonds of the United States or of the several States, or in bonds or notes secured by first mortgages on real estate, in investments legal for savings banks under the laws of Massachusetts or New York, or in other bonds recommended to the treasurer by the fiscal advisers of the academy.

The treasurer may invest the capital of all trust funds of the academy which are not required by the instruments creating such funds to be kept separate and distinct, in a consolidated fund, and shall apportion the income received from such consolidated fund among the various funds composing the same in the proportion that each of said funds shall bear to the total amount of funds so invested; provided, however, that the treasurer shall at all times keep accurate accounts showing the amount of each trust fund, the proportion of the income from the consolidated fund to which it is entitled, and the expenses and disbursements properly chargeable to such fund.

SEC. 2. The council shall at its annual meeting in each year designate one bank or trust company in Washington, D. C., and one in New York City, to act, when requested by the treasurer, as the fiscal advisers of the academy.

SEC. 3. The treasurer shall have authority, with the approval of the finance committee, to sell, transfer, convey, and deliver in the corporate name and for the benefit of the academy any stocks, bonds, or other securities standing in the corporate name.

SEC. 4. No contract shall be binding upon the academy which has not been first approved by the council.

SEC. 5. The assessments required for the support of the academy shall be fixed by the academy on the recommendation of the council and shall be payable within the calendar year for which they are assessed.

ARTICLE VII.—OF TRUST FUNDS AND THEIR ADMINISTRATION.

SECTION 1. Devises, bequests, donations, or gifts having for their object the promotion of science or the welfare of the academy may be accepted by the council for the academy. Before the acceptance of any such trust the council shall consider the object of the trust and all conditions or specifications attaching thereto. The council shall make a report of its action to the academy.

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SEC. 2. Medals and prizes may be established in accordance with the provisions of trusts or by action of the academy.

SEC. 3. Unless otherwise provided by the deed of gift, the income of each trust fund shall be applied to the objects of that trust by the action of the academy on the recommendation of a standing committee on that fund.

ARTICLE VIII.—OF ADDITIONS AND AMENDMENTS.

Additions and amendments to the constitution shall be made only at a stated meeting of the academy. Notice of a proposition for such a change must be submitted to the council, which may amend the proposition, and shall report thereon to the academy. Its report shall be considered by the academy in committee of the whole for amendment.

The proposition as amended, if adopted in committee of the whole, shall be voted on at the next stated meeting, and if it receives two-thirds of the votes cast it shall be declared adopted.

Absent members may send their votes on pending changes in the constitution to the home secretary in writing, and such votes shall be counted as if the members were present.

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APPENDIX B.

RULES.

(In accordance with a resolution of the academy, taken at its meeting on April 21, 1915, the rules are arranged in groups and each group is numbered to correspond with the article of the constitution to which it relates.)

I.

1. The holders of the medal for eminence in the application of science to the public welfare shall be notified, like members, of the meetings of the academy, and invited to participate in its scientific sessions.

II.

1. The proper secretary shall acknowledge all donations made to the academy, and shall at once report them to the council for its consideration.

2. The home secretary shall be the custodian of all books, apparatus, archives, and collections not explicitly assigned to other care.

3. The home secretary shall keep a record of all grants of money or awards of prizes or medals made from trust funds of the academy. The record for each grant of money shall include the following items:

1. Name of fund.
2. Date and number of the grant.
3. Name and address of recipient.
4. Amount of grant and date or dates of payment.
5. Purpose of grant.
6. Record or report of progress.
7. Resulting publications.

4. The treasurer shall keep the home secretary informed of all warrants received from directors of trust funds not controlled by the academy and of the date or dates of payment of all warrants.

5. The treasurer is authorized to defray, when approved by the president, all the proper expenses of committees appointed to make scientific investigations at the request of departments of the Government, and in each case to look to the department requesting the investigation for reimbursement to the academy.

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III.

1. At the business sessions of the academy the order of procedure shall be as follows:

1. Chair taken by the president, or, in his absence, by the vice president.

2. Roll of members called by home secretary (first session of the meeting only).

3. Minutes of the preceding session read and approved.

4. Stated business.

5. Reports of president, secretaries, treasurer, and committees.

6. Business from council.

7. Other business.

2. The rules of order of the academy shall be those of the Senate of the United States, unless otherwise provided by the constitution or rules of the academy.

3. In the absence of any officer a member shall be chosen to perform his duties temporarily, by a plurality of *viva voce* votes, upon open nomination.

4. At each meeting the president shall announce the death of any members since the preceding meeting. As soon as practicable thereafter he shall designate a member to write—or to secure from some other source approved by the president—a biographical notice of each deceased member.

5. A standing committee of three members called the program committee, a local committee of five members appointed for each meeting, and the home secretary shall together constitute the committee of arrangements, of which the home secretary shall be chairman.

The term of service on the program committee shall be three years, one member retiring annually, the chairman to be designated by the president.

It shall be the duty of the program committee to prepare the scientific program for the annual meeting, and for this purpose it shall be empowered to solicit papers from members or others. It shall also be empowered to ascertain the length of time required for reading papers to be presented at the scientific sessions of the academy, and, when it appears advisable, to limit the time to be occupied in their presentation or discussion.

The local committee shall meet not less than two months previous to each meeting. It shall prepare the detailed program of each day, and in general shall have charge of all business and scientific arrangements for the meeting for which it is appointed except those specifically assigned to the program committee in the case of the annual meeting.

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IV.

1. The term of service of each chairman of a section shall be three years, to date from the closing session of the April meeting next following his election. Chairmen of sections shall be chosen by mail ballot, the member receiving the highest number of votes cast to be deemed elected. It shall be the duty of each retiring chairman to conduct the election of his successor and to report the result of the election to the home secretary before the April meeting at which his term of service expires. Should any section fail to elect a chairman before November 1, the president is empowered to appoint a temporary chairman to serve until the April meeting next following. No chairman shall be eligible for reelection for two consecutive terms.

2. The chairman of each section of the academy shall submit to the members of his section, not later than November 1 of each year, a ballot containing the names of all those persons who received not less than two votes in the nominating ballot of the preceding year and of any other persons who were newly proposed for consideration at that time. Each member of the section shall be expected to return this ballot to the chairman within two weeks with his signature and with crosses placed against the names of those persons whom he is prepared to endorse for nomination. Each member may also write upon the ballot in a place provided for the purpose any new names which he desires to have included in the ballot to be submitted to the section in the following year. The vote resulting from this ballot shall be regarded as informal.

The chairman shall then submit to the members of his section a new ballot showing the results of the informal vote; and each member shall be expected to return this ballot to the chairman with his signature and with crosses placed against the names of those persons whom he will endorse for nomination.

The chairman shall then certify to the home secretary, prior to January 1, the names of those persons who have been voted for on this second ballot by a majority of the members of the section, and shall furnish him a list of the publications of these nominees, as required by the constitution.

3. Nominations for membership shall give the full name, residence, and the official positions successively held by the candidate, in addition to the list of his contributions to science required by the constitution.

4. Preference ballots for election of members shall be sealed in a blank envelope, which shall be inclosed in another bearing the name of the sender, and which shall be addressed to the home secretary. Such envelopes shall be opened only by the tellers. If in any case the

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tellers are unable to determine who cast a ballot, or if the latter contains more names than are to be voted for, the ballot shall be rejected, but minor defects in a ballot shall be disregarded when the intent of the voter is obvious.

5. All discussions of the claims and qualifications of nominees at meetings of the academy shall be held strictly confidential, and remarks and criticisms then made may be communicated to no person who was not a member of the academy at the time of the discussion.

V.

1. The publication of the Proceedings shall be under the general charge of the council, which shall have final jurisdiction upon all questions of policy relating thereto. The preparation of the Proceedings for publication shall be entrusted to an editorial board. This board shall consist of a chairman and a managing editor, both of whom shall be appointed by the council for definite terms of service; of the home secretary and foreign secretary *ex officiis*, and of a body of associate editors representing the various branches of science which are to be included in the scope of the proceedings. The managing editor, who may be a non-member of the academy, shall receive a salary, which shall be fixed by the council. It shall be the duty of the managing editor to prepare the proceedings in detail for publication; but the chairman of the editorial board shall decide, in consultation with the managing editor, in regard to the acceptance, rejection, or substantial modification of papers offered for publication. The associate editors shall be appointed by the council, upon recommendation of the chairman of the editorial board, for a period of three years, one-third of them retiring annually. The home secretary and the foreign secretary shall be responsible for the distribution of the proceedings in their respective fields.

2. Memoirs may be presented at any time to the home secretary, who shall report the date of their reception at the next session; but no memoir shall be published unless it has been read or presented by title before the academy.

Before publication all biographical and scientific memoirs must be referred to the committee on publication, who may, if they deem best, refer any memoir to a special committee appointed by the president to determine whether the same should be published by the academy.

3. Memoirs shall date, in the records of the academy, from the date of their presentation to the academy, and the order of their presentation shall be so arranged by the secretary that, so far as may be convenient, those upon kindred topics shall follow one another.

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4. The annual report of the treasurer shall contain:

1. A concise statement of the source, object, and amount of all trust funds of the academy.

2. A condensed statement of receipts and expenditures.

3. A statement of assets and liabilities.

4. Accounts with individual funds.

5. Such other matter as he considers appropriate.

5. The accounts of the treasurer shall, between January 1 and January 15 of each year, be audited by a committee of three members to be appointed by the president at the autumn meeting of the academy. It shall be the duty of the auditing committee to verify the record of receipts and disbursements maintained by the treasurer and the agreement of book and bank balances; to examine all securities in the custody of the treasurer and to compare the stated income of such securities with the receipts of record; to examine all vouchers covering disbursements for account of the academy and the authority therefor and to compare them with the treasurer's record of expenditures; to examine and verify the account of the academy with each trust fund. The auditing committee may employ an expert accountant to assist the committee in the examination of the books of the treasurer. The annual report of the treasurer shall be published with that of the president to Congress. The reports of the treasurer and auditing committee shall be presented to the academy at the annual meeting.

VI.

1. All apparatus and other materials of permanent value purchased with money from any grant from a trust fund shall be the property of the academy unless specific exception is made in the grant or by subsequent action of the council or the directors of the trust fund concerned. Receipts for all such property shall be signed by the grantee and shall be forwarded to the home secretary. All apparatus and unused material of value acquired in this way shall be delivered to the home secretary on completion of the investigation for which the grant was made, or at any time on demand of the council, and the home secretary shall give an appropriate release therefor.

2. The books, apparatus, archives, and other collections of the academy shall be deposited in some safe place in the city of Washington. A list of the articles so deposited shall be kept by the home secretary, who is authorized to employ a clerk to take charge of them.

3. A stamp corresponding to the corporate seal of the academy shall be kept by the secretaries, who shall be responsible for the due marking of all books and other objects to which it is applicable.

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Labels or other proper marks of similar device shall be placed upon objects not admitting of the stamp.

4. The fiscal year of the academy shall end on December 31 of each year.

5. The standing committee on finance shall consist of the treasurer *ex officio* as chairman and two members to be appointed annually by the president.

VII.

1. Standing committees of the academy on trust funds the income of which is applied to the promotion of research shall consist of three or five members. In order to secure rotation in office in such committees, when not in conflict with the provisions of the deeds of gift, the term of service on a committee of three members shall be three years; on a committee of five members the term shall be five years.

2. The annual reports of the committees on research funds shall, so far as the academy has authority to determine their form, give a current number to each award, stating the name, position, and address of the recipient, the subject of research for which the award is made, and the sum awarded; and in later annual reports the status of the work accomplished under each award previously made shall be announced, until the research is completed, when announcement of its completion and, if published, the title and place of publication shall be stated, and the record of the award shall be reported as closed.

VIII.

1. Any rule of the academy may be amended, suspended, or repealed on the written motion of any two members, signed by them, and presented at a stated meeting of the academy, provided the same shall be approved by a majority of the members present.

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APPENDIX C.

ORGANIZATION OF THE ACADEMY, 1915–16.

	Expiration of term.
WELCH, WILLIAM H., *President*	April, 1919
WALCOTT, CHARLES D., *Vice President*	April, 1919
HALE, GEORGE E., *Foreign Secretary*	April, 1916
DAY, ARTHUR L., *Home Secretary*	April, 1919
CROSS, WHITMAN, *Treasurer*	April, 1917

ADDITIONAL MEMBERS OF COUNCIL.

1913–1916.

CHITTENDEN, R. H. — WILSON, EDMUND B.

1914–1917.

CONKLIN, E. G. — NOYES, A. A.

1915–1918.

COULTER, J. M. — HOWELL, W. H.

SECTIONS.

1. MATHEMATICS.

BÔCHER, MAXIME
BOLZA, OSKAR
DICKSON, L. E.
MOORE, E. H. (*Acting Chairman*)
MOULTON, F. R.
OSGOOD, W. F.
STORY, W. E.
VAN VLECK, E. B.
WEBSTER, A. G.
WHITE, H. S.
WOODWARD, R. S.

2. ASTRONOMY.

ABBOT, C. G.
BARNARD, E. E.
CAMPBELL, W. W.
COMSTOCK, G. C. (*Acting Chairman*)
ELKIN, W. L.
FROST, E. B.
HALE, G. E.
LEUSCHNER, A. O.
MOULTON, F. R.
PICKERING, E. C.
WOODWARD, R. S.

3. PHYSICS AND ENGINEERING.

ABBE, CLEVELAND
ABBOT, H. L.
AMES, J. S.
BARUS, CARL
BELL, A. G.
BUMSTEAD, H. A.
CREW, HENRY
HALL, E. H.
HASTINGS, C. S.
HAYFORD, J. F.
MENDENHALL, T. C.
MERRITT, ERNEST
MICHELSON, A. A.
MILLIKAN, R. A.
MORLEY, E. W.
NICHOLS, E. F.
NICHOLS, E. L.
PICKERING, E. C.
PUPIN, M. I.
ROSA, E. B.
THOMSON, ELIHU
TROWBRIDGE, JOHN
WEBSTER, A. G.
WOOD, R. W.
WOODWARD, R. S. (*Acting Chairman*)

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4. CHEMISTRY.

BOLTWOOD, B. B.
CHANDLER, C. F.
CHITTENDEN, R. H.
CLARKE, F. W.
CRAFTS, J. M.
FRANKLIN, E. C.
GOMBERG, MOSES
GOOCH, F. A.
HILGARD, E. W.[1]
HILLEBRAND, W. F.
JACKSON, C. L.
LEWIS, G. N.
MICHAEL, ARTHUR
MORLEY, E. W.
MORSE, H. N.
NOYES, A. A. (*Acting Chairman*)
NOYES, W. A.
OSBORNE, T. B.
REMSEN, IRA
RICHARDS, T. W.
SMITH, ALEXANDER
SMITH, EDGAR F.
STIEGLITZ, J. O.
WELLS, H. L.

5. GEOLOGY AND PALEONTOLOGY.

BECKER, G. F.
BRANNER, J. C.
CHAMBERLIN, T. C.
CLARK, W. B.
CLARKE, J. M.
CROSS, WHITMAN
DALL, W. H.
DANA, E. S.
DAVIS, W. M.
DAY, A. L.
GILBERT, G. K.
HAGUE, ARNOLD (*Acting Chairman*)
IDDINGS, J. P.
KEMP, J. F.
LINDGREN, WALDEMAR
OSBORN, H. F.
PIRSSON, L. V.
PUMPELLY, RAPHAEL
RANSOME, F. L.
REID, H. F.
SCHUCHERT, CHARLES
SCOTT, W. B.
VAN HISE, C. R.
WALCOTT, C. D.
WHITE, DAVID
WILLISTON, S. W.

6. BOTANY.

BRITTON, N. L.
CAMPBELL, D. H.
COULTER, J. M. (*Chairman, 1915–1918*)
FARLOW, W. G.
GOODALE, G. L.
HARPER, R. A.
SARGENT, C. S.
SMITH, ERWIN F.
THAXTER, ROLAND
TRELEASE, WILLIAM

7. ZOOLOGY AND ANIMAL MORPHOLOGY.

ALLEN, J. A.
CASTLE, W. E.
CONKLIN, E. G. (*Acting Chairman*)
DALL, W. H.
DAVENPORT, C. B.
DONALDSON, H. H.
HARRISON, R. G.
JENNINGS, H. S.
LILLIE, F. R.
MALL, F. P.
MARK, E. L.
MERRIAM, C. H.
MORGAN, T. H.
MORSE, E. S.
OSBORN, H. F.
PARKER, G. H.
VERRILL, A. E.
WALCOTT, C. D.
WHEELER, W. M.
WILSON, EDMUND B.

8. PHYSIOLOGY AND PATHOLOGY.

ABEL, J. J.
BENEDICT, F. G.
CANNON, W. B.
CHITTENDEN, R. H. (*Acting Chairman*)
COUNCILMAN, W. T.
FLEXNER, SIMON
HOWELL, W. H.
LOEB, JACQUES
LUSK, GRAHAM
MALL, F. P.
MELTZER, S. J.
MENDEL, L. B.
PRUDDEN, T. M.
SMITH, THEOBALD
VAUGHAN, V. C.
WELCH, W. H.
WOOD, H. C.

9. ANTHROPOLOGY AND PSYCHOLOGY.

BOAS, FRANZ
CATTELL, J. McK.
DEWEY, JOHN
FEWKES, J. W.
HALL, G. S.
HOLMES, W. H. (*Acting Chairman*)
MERRIAM, C. H.
MORSE, E. S.
ROYCE, JOSIAH

[1] Died Jan. 8, 1916.

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STANDING COMMITTEES.

ON WEIGHTS, MEASURES, AND COINAGE.

MENDENHALL, T. C. (*Chairman*) MICHELSON, A. A. MORLEY, E. W.
WEBSTER, A. G. WOODWARD, R. S.

ON SOLAR RESEARCH.

HALE, G. E. (*Chairman*) CAMPBELL, W. W. MICHELSON, A. A.
NICHOLS, E. L. PICKERING, E. C.

ON PUBLICATION.

The PRESIDENT. The HOME SECRETARY. WALCOTT, C. D.

EDITORIAL BOARD OF THE PROCEEDINGS.

NOYES, A. A. (*Chairman*) WILSON, EDWIN B. (*Managing Editor*)
DAY, A. L. (*Home Secretary*) HALE, G. E. (*Foreign Secretary*)

ABEL, J. J., 1918.	COULTER, J. M., 1916.	HOLMES, W. H., 1917.
CANNON, W. B., 1916.	DAVENPORT, C. B., 1917.	IDDINGS, J. P., 1918.
CATTELL, J. McK., 1916.	FLEXNER, SIMON, 1916.	MILLIKAN, R. A., 1918.
CLARKE, J. M., 1918.	FROST, E. B., 1917.	MOORE, E. H., 1917.
CONKLIN, E. G., 1917.	HARRISON, R. G., 1916.	SMITH, ALEXANDER, 1918.

ON COLLECTION OF HISTORICAL PORTRAITS, MANUSCRIPTS, INSTRUMENTS, ETC.

WALCOTT, C. D. (*Chairman*) CLARKE, F. W. HAGUE, ARNOLD
HALE, G. E. MELTZER, S. J. PUPIN, M. I.

ON PROGRAM.

BOLTWOOD, B. B. (*Chairman*), 1918. CATTELL, J. McK., 1916.
FROST, E. B., 1917.

FINANCE COMMITTEE.

CROSS, WHITMAN (*Chairman*) HAGUE, ARNOLD WALCOTT, C. D.

TRUST FUNDS.

THE BACHE FUND.

[$56,000.]

Researches in physical and natural science.

FROST, E. B. (*Chairman*) HARRISON, R. G. WEBSTER, A. G.

THE WATSON FUND.

[$25,000.]

Watson Medal and the promotion of astronomical research.

PICKERING, E. C. (*Chairman*) ELKIN, W. L. FROST, E. B.

THE HENRY DRAPER FUND.

[$10,000.]

Draper Medal and investigations in astronomical physics.

HALE, G. E. (*Chairman*), 1918. AMES, J. S., 1920. CAMPBELL, W. W., 1919.
MICHELSON, A. A., 1917. TROWBRIDGE, JOHN, 1916.

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THE J. LAWRENCE SMITH FUND.

[$10,000.]

J. Lawrence Smith Medal and investigations of meteoric bodies.

MORLEY, E. W. (*Chairman*), 1919. DANA, E. S., 1918. HAGUE, ARNOLD, 1917.
PICKERING, E. C., 1920. REMSEN, IRA, 1916.

THE BARNARD MEDAL.[1]

Meritorious service to science.

WOODWARD, R. S. (*Chairman*) CAMPBELL, W. W. NICHOLS, E. F.
NOYES, A. A. RICHARDS, T. W.

THE BENJAMIN APTHORP GOULD FUND.

[$20,000.]

Researches in astronomy.

MOULTON, F. R. (*Chairman*) BARNARD, E. E. WOODWARD, R. S.

THE WOLCOTT GIBBS FUND.

[$5,500.]

Chemical research.

JACKSON, C. L. (*Chairman*) RICHARDS. T. W. SMITH, EDGAR F.

THE COMSTOCK FUND.

[$11,337.50.]

Researches in electricity, magnetism, and radiant energy.

NICHOLS, E. L. (*Chairman*), 1918. CREW, HENRY, 1916. NOYES, A. A., 1919.
THOMSON, ELIHU, 1920. WEBSTER, A. G., 1917.

THE MARSH FUND.

[$10,127.65.]

Original research in the natural sciences.

THE AGASSIZ FUND.

[$50,000.]

General uses of the Academy.

THE MURRAY FUND.

[$6,000.]

Agassiz Medal and contributions to oceanography.

HAGUE, ARNOLD (*Chairman*), 1916. DALL, W. H., 1918. PARKER, G. H., 1917.

THE MARCELLUS HARTLEY FUND.

[$1,200.]

Medal for eminence in the application of science to the public welfare.

BECKER, G. F. (*Chairman*)

HILLEBRAND, W. F.	PUPIN, M. I.	WEBSTER, A. G.
OSBORN, H. F.	SMITH, THEOBALD	WELCH, W. H.

[1] Every five years the committee recommends the person whom they consider most deserving of the medal, and upon the approval of the Academy the name of the nominee is forwarded to the trustees of Columbia University, who administer the Barnard Medal Fund.

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THE JOSEPH HENRY FUND.

To assist meritorious investigators, especially in the direction of original research.

The sum of $40,000 was contributed by Fairman Rogers, Joseph Patterson, George W. Childs, and others, as an expression of their respect and esteem for Prof. Joseph Henry. This amount was deposited with the Pennsylvania Company for the Insurance of Lives and Granting Annuities in Trust, with authorization to collect the income thereon and to pay over the same to Prof. Joseph Henry during his natural life, and after his death to his wife and daughters, and after the death of the last survivor to "deliver the said fund and the securities in which it shall then be invested to the National Academy of Sciences, to be thenceforward forever held in trust under the name and title of the 'Joseph Henry Fund.'"

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MEMBERS OF THE NATIONAL ACADEMY OF SCIENCES, DECEMBER 31, 1915.

		Date of election.
ABBE, CLEVELAND	*U. S. Weather Bureau, Washington, D. C.*	1879
ABBOT, CHARLES GREELEY	*Smithsonian Institution, Washington, D. C.*	1915
ABBOT, HENRY L., U. S. A	*23 Berkeley St., Cambridge, Mass.*	1872
ABEL, JOHN JACOB	*Johns Hopkins University, Baltimore, Md.*	1912
ALLEN, J. ASAPH	*American Museum of Natural History, N. Y. City.*	1876
AMES, JOSEPH S	*Johns Hopkins University, Baltimore, Md.*	1909
BARNARD, E. E	*Yerkes Observatory, Williams Bay, Wis.*	1911
BARUS, CARL	*Brown University, Providence, R. I.*	1892
BECKER, GEORGE F	*U. S. Geological Survey, Washington, D. C.*	1901
BELL, A. GRAHAM	*1331 Connecticut Ave., Washington, D. C.*	1883
BENEDICT, FRANCIS GANO	*Nutrition Laboratory, Boston, Mass.*	1914
BOAS, FRANZ	*Columbia University, New York City.*	1900
BÔCHER, MAXIME	*Harvard University, Cambridge, Mass.*	1909
BOLTWOOD, B. B	*Yale University, New Haven, Conn.*	1911
BOLZA, OSKAR	*Reichsgrafenstr. 10, Freiburg, Germany.*	1909
BRANNER, JOHN C	*Stanford University, California.*	1905
BRITTON, NATHANIEL LORD	*New York Botanical Gardens, N. Y. City.*	1914
BUMSTEAD, HENRY ANDREWS	*Yale University, New Haven, Conn.*	1913
CAMPBELL, D. H	*Stanford University, California.*	1910
CAMPBELL, WILLIAM W	*Lick Observatory, Mount Hamilton, California.*	1902
CANNON, WALTER BRADFORD	*Harvard University, Cambridge, Mass.*	1914
CASTLE, WILLIAM ERNEST	*186 Payson Road, Belmont, Mass.*	1915
CATTELL, JAMES MCK	*Garrison, N. Y.*	1901
CHAMBERLIN, THOMAS C	*University of Chicago, Chicago, Ill.*	1903
CHANDLER, CHARLES F	*Columbia University, New York City.*	1874
CHITTENDEN, RUSSELL H	*Sheffield Scientific School, New Haven, Conn.*	1890
CLARK, W. B	*Johns Hopkins University, Baltimore, Md.*	1908
CLARKE, F. W	*U. S. Geological Survey, Washington, D. C.*	1909
CLARKE, J. M	*State Hall, Albany, N. Y.*	1909
COMSTOCK, GEORGE C	*Washburn Observatory, Madison, Wis.*	1899
CONKLIN, E. G	*Princeton, N. J.*	1908
COULTER, J. M	*University of Chicago, Chicago, Ill.*	1909
COUNCILMAN, WILLIAM T	*Harvard Medical School, Boston, Mass.*	1904
CRAFTS, JAMES M	*19 Commonwealth Ave., Boston, Mass.*	1872
CREW, HENRY	*Northwestern University, Evanston, Ill.*	1909
CROSS, WHITMAN	*U. S. Geological Survey, Washington, D. C.*	1908
DALL, WILLIAM H	*Smithsonian Institution, Washington, D. C.*	1897
DANA, EDWARD S	*Yale University, New Haven, Conn.*	1884
DAVENPORT, CHARLES B	*Cold Spring Harbor, N. Y.*	1912
DAVIS, WILLIAM MORRIS	*31 Hawthorn St., Cambridge, Mass.*	1904
DAY, ARTHUR L	*Geophysical Laboratory, Washington, D. C.*	1911
DEWEY, JOHN	*Columbia University, New York City.*	1910
DICKSON, LEONARD E	*University of Chicago, Chicago, Ill.*	1913
DONALDSON, HENRY HERBERT	*Wistar Institute of Anatomy, Phila., Pa.*	1914

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		Date of election.
ELKIN, WILLIAM L.	*Yale University Observatory, New Haven, Conn.*	1895
FARLOW, W. G.	*Harvard University, Cambridge, Mass.*	1879
FEWKES, JESSE WALTER	*Bureau of American Ethnology, Wash., D. C.*	1914
FLEXNER, SIMON	*Rockefeller Institute, New York City.*	1908
FRANKLIN, EDWARD CURTIS	*Stanford University, California.*	1914
FROST, EDWIN B.	*Yerkes Observatory, Williams Bay, Wis.*	1908
GILBERT, GROVE K.	*U. S. Geological Survey, Washington, D. C.*	1883
GOMBERG, MOSES	*University of Michigan, Ann Arbor, Mich.*	1914
GOOCH, FRANK A.	*Yale University, New Haven, Conn.*	1897
GOODALE, GEORGE L.	*Harvard University, Cambridge, Mass.*	1890
HAGUE, ARNOLD	*U. S. Geological Survey, Washington, D. C.*	1885
HALE, GEORGE E.	*Solar Observatory Office, Pasadena, Cal.*	1902
HALL, EDWIN H.	*Harvard University, Cambridge, Mass.*	1911
HALL, GRANVILLE STANLEY	*Clark University, Worcester, Mass.*	1915
HARPER, R. A.	*Columbia University, New York City.*	1911
HARRISON, ROSS G.	*Yale University, New Haven, Conn.*	1913
HASTINGS, CHARLES S.	*Yale University, New Haven, Conn.*	1889
HAYFORD, JOHN F.	*Northwestern University, Evanston, Ill.*	1911
HILGARD, EUGENE W.[1]	*University of California, Berkeley, Cal.*	1872
HILLEBRAND, WILLIAM F.	*Bureau of Standards, Washington, D. C.*	1908
HOLMES, WILLIAM H.	*U. S. National Museum, Washington, D. C.*	1905
HOWELL, WILLIAM H.	*Johns Hopkins University, Baltimore, Md.*	1905
IDDINGS, JOSEPH P.	*U. S. Geological Survey, Washington, D. C.*	1907
JACKSON, CHARLES L.	*6 Boylston Hall, Cambridge, Mass.*	1883
JENNINGS, HERBERT SPENCER	*Johns Hopkins University, Baltimore, Md.*	1914
KEMP, JAMES F.	*Columbia University, New York City.*	1911
LEUSCHNER, ARMIN O.	*University of California, Berkeley, Cal.*	1913
LEWIS, GILBERT N.	*University of California, Berkeley, Cal.*	1913
LILLIE, FRANK RATTRAY	*University of Chicago, Chicago, Ill.*	1915
LINDGREN, WALDEMAR	*Mass. Inst. of Technology, Boston, Mass.*	1909
LOEB, JACQUES	*Rockefeller Institute, New York City.*	1910
LUSK, GRAHAM	*Cornell University Medical College, New York City.*	1915
MALL, FRANKLIN P.	*Johns Hopkins University, Baltimore, Md.*	1907
MARK, EDWARD L.	*109 Irving St., Cambridge, Mass.*	1903
MELTZER, SAMUEL JAMES	*Rockefeller Institute, New York City.*	1912
MENDEL, LAFAYETTE B.	*18 Trumbull St., New Haven, Conn.*	1913
MENDENHALL, THOMAS C.	*329 North Chestnut St., Ravenna, Ohio.*	1887
MERRIAM, C. HART	*1919 16th St., Washington, D. C.*	1902
MERRITT, ERNEST	*Cornell University, Ithaca, N. Y.*	1914
MICHAEL, ARTHUR	*219 Parker St., Newton Center, Mass.*	1889
MICHELSON, ALBERT A.	*University of Chicago, Chicago, Ill.*	1888
MILLIKAN, ROBERT ANDREWS	*University of Chicago, Chicago, Ill.*	1915
MOORE, ELIAKIM H.	*University of Chicago, Chicago, Ill.*	1901
MORGAN, T. H.	*Columbia University, New York City.*	1909
MORLEY, EDWARD W.	*West Hartford, Conn.*	1897
MORSE, EDWARD S.	*Salem, Mass.*	1876
MORSE, HARMON N.	*Johns Hopkins University, Baltimore, Md.*	1907
MOULTON, F. R.	*University of Chicago, Chicago, Ill.*	1910
NICHOLS, EDWARD L.	*Cornell University, Ithaca, N. Y.*	1901
NICHOLS, ERNEST F.	*Dartmouth College, Hanover, N. H.*	1908

[1] Died Jan. 8, 1916.

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		Date of election.
NOYES, ARTHUR A.	*Massachusetts Institute of Technology, Boston, Mass.*	1905
NOYES, WILLIAM A.	*University of Illinois, Urbana, Ill.*	1910
OSBORN, H. F.	*American Museum of Natural History, New York City.*	1900
OSBORNE, T. B.	*Agricultural Experiment Station, New Haven, Conn.*	1910
OSGOOD, WILLIAM FOGG.	*Harvard University, Cambridge, Mass.*	1904
PARKER, GEORGE H.	*16 Berkeley St., Cambridge, Mass.*	1913
PICKERING, EDWARD C.	*Harvard College Observatory, Cambridge, Mass.*	1873
PIRSSON, LOUIS V.	*41 Trumbull St., New Haven, Conn.*	1913
PRUDDEN, T. MITCHELL.	*Columbia University, New York City.*	1901
PUMPELLY, RAPHAEL.	*Gibbs Ave., Newport, R. I.*	1872
PUPIN, MICHAEL I.	*Columbia University, New York City.*	1905
RANSOME, FREDERICK LESLIE.	*U. S. Geological Survey, Washington, D. C.*	1914
REID, H. FIELDING.	*Johns Hopkins University, Baltimore, Md.*	1912
REMSEN, IRA.	*Johns Hopkins University, Baltimore, Md.*	1882
RICHARDS, THEODORE W.	*Wolcott Gibbs Mem. Lab., Cambridge, Mass.*	1899
ROSA, EDWARD B.	*Bureau of Standards, Washington, D. C.*	1913
ROYCE, JOSIAH.	*Harvard University, Cambridge, Mass.*	1906
SARGENT, CHARLES S.	*Arnold Arboretum, Jamaica Plain, Mass.*	1895
SCHUCHERT, CHARLES.	*Yale University, New Haven, Conn.*	1910
SCOTT, WILLIAM B.	*Princeton University, Princeton, N. J.*	1906
SMITH, ALEXANDER.	*Columbia University, New York City.*	1915
SMITH, EDGAR F.	*University of Pennsylvania, Philadelphia, Pa.*	1899
SMITH, ERWIN F.	*Bureau of Plant Industry, Washington, D. C.*	1913
SMITH, THEOBALD.	*Princeton, N. J.*	1908
STIEGLITZ, J. O.	*University of Chicago, Chicago, Ill.*	1911
STORY, WILLIAM E.	*Clark University, Worcester, Mass.*	1908
THAXTER, ROLAND.	*Harvard University, Cambridge, Mass.*	1912
THOMSON, ELIHU.	*Swampscott, Mass.*	1907
TRELEASE, WILLIAM.	*University of Illinois, Urbana, Ill.*	1902
TROWBRIDGE, JOHN.	*Harvard University, Cambridge, Mass.*	1878
VAN HISE, C. R.	*University of Wisconsin, Madison, Wis.*	1902
VAN VLECK, E. B.	*University of Wisconsin, Madison, Wis.*	1911
VAUGHAN, VICTOR CLARENCE.	*University of Michigan, Ann Arbor, Mich.*	1915
VERRILL, A. E.	*Yale University, New Haven, Conn.*	1872
WALCOTT, CHARLES D.	*Smithsonian Institution, Washington, D. C.*	1896
WEBSTER, ARTHUR G.	*Clark University, Worcester, Mass.*	1903
WELCH, WILLIAM H.	*807 St. Paul St., Baltimore, Md.*	1895
WELLS, HORACE L.	*Yale University, New Haven, Conn.*	1903
WHEELER, WILLIAM M.	*Harvard University, Cambridge, Mass.*	1912
WHITE, DAVID.	*U. S. Geological Survey, Washington, D. C.*	1912
WHITE, HENRY SEELY.	*Vassar College, Poughkeepsie, N. Y.*	1915
WILLISTON, SAMUEL WENDELL.	*University of Chicago, Chicago, Ill.*	1915
WILSON, EDMUND B.	*Columbia University, New York City.*	1899
WOOD, HORATIO C.	*4107 Chester Ave., Philadelphia, Pa.*	1879
WOOD, ROBERT W.	*Johns Hopkins University, Baltimore, Md.*	1912
WOODWARD, ROBERT S.	*Carnegie Institution, Washington, D. C.*	1896

HONORARY MEMBER.

SMITH, SIDNEY I.	*Yale University, New Haven, Conn.*	1884

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FOREIGN ASSOCIATES.

		Date of election.
ARRHENIUS, S. A.	*Nobelinstitut, Stockholm.*	1908
BACKLUND, OSKAR	*Astronomical Observatory, Poulkova.*	1903
BAEYER, ADOLPH RITTER VON	*Universität, Munich.*	1898
BARROIS, CHARLES	*Université, Lille.*	1908
BRØGGER, W. C.	*Universitet, Christiania.*	1908
CROOKES, SIR WILLIAM	*London.*	1913
DARBOUX, GASTON	*Academy of Sciences, Paris.*	1913
DESLANDRES, HENRI	*Astrophysical Observatory, Meudon.*	1913
DEWAR, SIR JAMES	*University, Cambridge.*	1907
FISCHER, EMIL	*Chemisches Institut der Universität, Berlin.*	1904
FORSYTH, A. R.	*Trinity College, Cambridge.*	1907
GEIKIE, SIR ARCHIBALD	*Haslemere, Surrey.*	1901
GROTH, PAUL VON	*Universität, Munich.*	1905
HEIM, ALBERT	*Zürich.*	1913
HILBERT, DAVID	*Universität, Göttingen.*	1907
KAPTEYN, JOHN C.	*Rijks Universiteit, Groningen.*	1907
KLEIN, FELIX	*Universität, Göttingen.*	1898
KÖSSEL, ALBRECHT	*Heidelberg.*	1913
KUSTNER, KARL FRIEDRICH	*Bonn.*	1913
LANKESTER, E. RAY	*South Kensington, London.*	1903
LARMOR, SIR JOSEPH	*St. Johns College, Cambridge.*	1908
LORENTZ, HENDRIK ANTON	*Rijks Universiteit, Leiden.*	1906
OSTWALD, WILHELM	*Grossbothen, bei Leipzig.*	1906
PAVLOV, IVAN PETROVITCH	*Imperial Institute for Experimental Medicine, Petrograd.*	1908
PENCK, ALBRECHT	*Universität, Berlin.*	1909
PFEFFER, WILHELM	*Botanische Institut der Universität, Leipzig.*	1903
PICARD, CHARLES ÉMILE	*Université, Paris.*	1903
RAMSAY, SIR WILLIAM	*University College, London.*	1904
RAYLEIGH, LORD	*University, Cambridge.*	1898
RETZIUS, GUSTAV	*Högskolan, Stockholm.*	1909
RUTHERFORD, ERNEST	*University, Manchester.*	1911
SCHUSTER, ARTHUR	*Secretary of the Royal Society, London.*	1913
SEELIGER, HUGO RITTER VON	*Universität, Munich.*	1908
THOMSON, SIR JOSEPH	*University, Cambridge.*	1903
VOLTERRA, VITO	*Università, Rome.*	1911
VRIES, HUGO DE	*Universiteit, Amsterdam.*	1904
WAALS, JOHANNES D. VAN DER	*Amsterdam.*	1913
WALDEYER, WILHELM	*Universität, Berlin.*	1909
WOLF, MAX F. J. C.	*Heidelberg.*	1913
WUNDT, WILHELM	*Universität, Leipzig.*	1909

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DECEASED MEMBERS.

	Date of election.	Date of death.
AGASSIZ, ALEXANDER	1866	Mar. 27, 1910
AGASSIZ, LOUIS	(1)	Dec. 14, 1873
ALEXANDER, J. H	(1)	Mar. 2, 1867
ALEXANDER, STEPHEN	(1)	June 25, 1883
BACHE, ALEXANDER DALLAS	(1)	Feb. 14, 1867
BAIRD, SPENCER F	1864	Aug. 19, 1887
BARKER, GEORGE F	1876 [2]	May 24, 1910
BARNARD, F. A. P	(1) (2)	Apr. 27, 1889
BARNARD, J. G	(1)	May 14, 1882
BARTLETT, W. H. C	(1)	Feb. 11, 1893
BEECHER, CHARLES EMERSON	1899	Feb. 14, 1904
BILLINGS, JOHN S	1883 [2]	Mar. 11, 1913
BOSS, LEWIS	1889 [2]	Oct. 5, 1912
BOWDITCH, HENRY P	1887 [2]	Mar. 13, 1911
BREWER, WILLIAM H	1880 [2]	Nov. 2, 1910
BROOKS, WILLIAM KEITH	1884	Nov. 12, 1908
BROWN-SEQUARD, CHARLES E	1868	Apr. 2, 1894
BRUSH, GEORGE JARVIS	1868 [2]	Feb. 6, 1912
CASEY, THOMAS L	1890	Mar. 25, 1896
CASWELL, ALEXIS	(1)	Jan. 8, 1887
CHANDLER, SETH CARLO	1888 [2]	Jan. 10, 1914
CHAUVENET, WILLIAM	(1)	Dec. 13, 1870
CLARKE, HENRY JAMES	1872	July 1, 1873
COFFIN, JAMES	1869	Jan. 6, 1873
COFFIN, J. H. C	(1)	Jan. 8, 1890
COMSTOCK, CYRUS B	1884	May 29, 1910
COOK, GEORGE H	1887	Sept. 22, 1889
COOKE, JOSIAH P	1872	Sept. 3, 1894
COPE, EDWARD D	1872 [2]	Apr. 12, 1897
COUES, ELLIOTT	1877	Dec. 25, 1899
DALTON, J. C	1864	Feb. 2, 1889
DANA, JAMES D	(1) (2)	Apr. 14, 1895
DAVIDSON, GEORGE	1874 [2]	Dec. 2, 1911
DAVIS, CHARLES H	(1)	Feb. 14, 1877
DRAPER, HENRY	1877	Nov. 20, 1882
DRAPER, JOHN W	1877	Jan. 4, 1882
DUTTON, C. E	1884 [2]	Jan. 4, 1912
EADS, JAMES B	1872	Mar. 8, 1887
EMMONS, SAMUEL F	1892	Mar. 28, 1911
ENGLEMANN, GEORGE	(1)	Feb. 4, 1884
FERREL, WILLIAM	1868	Sept. 18, 1891
FRASER, JOHN FRIES	(1)	Oct. 12, 1872
GABB, WILLIAM M	1876	May 30, 1878
GENTH, F. A	1872	Feb. 2, 1893
GIBBS, JOSIAH WILLARD	1879	Apr. 28, 1903
GIBBS, WOLCOTT	(1)	Dec. 9, 1908
GILL, THEODORE NICHOLAS	1873 [2]	Sept. 25, 1914
GILLIS, JAMES MELVILLE	(1)	Feb. 9, 1865
GOODE, G. BROWN	1888	Sept. 6, 1896
GOULD, AUGUSTUS A	(1)	Sept. 15, 1866
GOULD, BENJAMIN A	(1) (2)	Nov. 27, 1896
GRAY, ASA	(1)	Jan. 30, 1888
GUYOT, ARNOLD	(1)	Feb. 8, 1884

[1] Charter members, March 3, 1863. [2] Biographical notices have not been presented.

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Deceased members—Continued.

	Date of election.	Date of death.
HADLEY, JAMES	1864	Aug. 1, 1872
HALDEMAN, S. S.	1876	Sept. 20, 1880
HALL, ASAPH	1875	Nov. 22, 1907
HALL, JAMES	(1) (2)	Aug. 8, 1898
HAYDEN, F. V.	1873	Dec. 22, 1887
HENRY, JOSEPH	(1)	May 13, 1878
HILGARD, JULIUS E.	(1)	May 8, 1891
HILL, GEORGE WILLIAM	1874	Apr. 6, 1914
HILL, HENRY B.	1883	Apr. 6, 1908
HITCHCOCK, EDWARD	(1)	Feb. 27, 1864
HOLBROOK, J. E.	1868	Sept. 8, 1871
HOLDEN, EDWARD SINGLETON	1885 [2]	Mar. 16, 1914
HUBBARD, J. S.	(1)	Aug. 16, 1863
HUMPHREYS, A. A.	(1)	Nov. 28, 1883
HUNT, T. STERRY	1873 [2]	Feb. 12, 1892
HYATT, ALPHEUS	1875	Jan. 16, 1902
JOHNSON, S. W.	1866	July 21, 1909
KEELER, J. E.	1900	Aug. 12, 1900
KING, CLARENCE	1876	Dec. 24, 1901
KIRTLAND, JARED P.	1865	Dec. 10, 1877
LANE, J. HOMER	1872	May 3, 1880
LANGLEY, SAMUEL P.	1876	Feb. 27, 1906
LEA, MATTHEW CAREY	1892	Mar. 15, 1897
LE CONTE, JOHN	1878	Apr. 29, 1891
LE CONTE, JOHN L.	(1)	Nov. 15, 1883
LE CONTE, JOSEPH	1875	July 6, 1901
LEIDY, JOSEPH	(1)	Apr. 30, 1891
LESLEY, J. PETER	(1)	June 3, 1903
LESQUEREUX, LEO	1864	Oct. 25, 1889
LONGSTRETH, MIERS F.	(1)	Dec. 27, 1891
LOOMIS, ELIAS	1873	Aug. 16, 1889
LOVERING, JOSEPH	1873	Jan. 18, 1892
LYMAN, THEODORE	1872	Sept. 10, 1897
MAHAN, D. H.	(1)	Sept. 16, 1871
MARSH, G. P.	1866	July 23, 1882
MARSH, O. C.	1874 [2]	Mar. 18, 1899
MAYER, ALFRED M.	1872	July 13, 1897
MAYO-SMITH, RICHMOND	1890 [2]	Nov. 11, 1901
MEEK, F. B.	1869	Dec. 21, 1877
MEIGS, M. C.	1865	Jan. 2, 1892
MINOT, CHARLES SEDGWICK	1897 [2]	Nov. 19, 1914
MITCHELL, HENRY	1885 [2]	Dec. 1, 1902
MITCHELL, SILAS WEIR	1865 [2]	Jan. 4, 1914
MORGAN, LEWIS H.	1875	Dec. 14, 1881
MORTON, HENRY	1874	May 9, 1902
NEF, JOHN ULRIC	1904 [2]	Aug. 13, 1915
NEWBERRY, J. S.	(1)	Dec. 7, 1892
NEWCOMB, SIMON	1869 [2]	July 11, 1909
NEWTON, H. A.	(1)	Aug. 1, 1896
NEWTON, JOHN	1876	May 1, 1895
NORTON, WILLIAM A.	1873	Sept. 21, 1883
OLIVER, JAMES E.	1872	Mar. 27, 1895
PACKARD, A. S.	1872 [2]	Feb. 14, 1905
PIERCE, BENJAMIN OSGOOD	1906 [2]	Jan. 14, 1914

[1] Charter members, March 3, 1863. [2] Biographical notices have not been presented.

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Deceased members—Continued.

	Date of election.	Date of death.
PIERCE, CHARLES SANTIAGO SANDERS	1876 [2]	Apr. 20, 1914
PENFIELD, SAMUEL L.	1900	Aug. 13, 1906
PETERS, C. H. F.	1876 [2]	July 18, 1890
POURTALES, L. F.	1873	July 19, 1880
POWELL, JOHN W.	1880	Sept. 23, 1902
PUTNAM, FREDERICK W.	1885 [2]	Aug. 14, 1915
RODGERS, JOHN.	(1)	May 5, 1882
ROGERS, FAIRMAN.	(1)	Aug. 23, 1900
ROGERS, ROBERT E.	(1)	Sept. 7, 1884
ROGERS, WILLIAM A.	1885	Mar. 1, 1896
ROGERS, WILLIAM B.	(1)	May 30, 1882
ROOD, OGDEN N.	1885	Nov. 12, 1902
ROWLAND, HENRY A.	1881	Apr. 16, 1901
RUTHERFURD, LEWIS M.	(1)	May 30, 1892
SAXTON, JOSEPH.	(1)	Oct. 26, 1873
SCHOTT, CHARLES A.	1872	July 31, 1901
SCUDDER, SAMUEL H.	1877 [2]	May 17, 1911
SELLERS, WILLIAM.	1873 [2]	Jan. 24, 1905
SILLIMAN, BENJ., Sr.	(1)	Nov. 24, 1864
SILLIMAN, BENJ., Jr.	(1)	Jan. 14, 1885
SMITH, J. LAWRENCE.	1872	Oct. 12, 1883
STIMPSON, WILLIAM.	1868 [2]	May 26, 1873
STRONG, THEODORE.	(1)	Feb. 1, 1869
SULLIVANT, W. S.	1873	Apr. 30, 1882
TORREY, JOHN.	(1)	Mar. 10, 1873
TOTTEN, J. G.	(1)	Apr. 22, 1864
TROWBRIDGE, WILLIAM P.	1872	Aug. 12, 1892
TRUMBULL, JAMES H.	1872	Aug. 5, 1897
TUCKERMAN, EDWARD.	1868	Mar. 15, 1886
WALKER, FRANCIS A.	1878	Jan. 5, 1897
WARREN, G. K.	1876	Aug. 8, 1882
WATSON, JAMES C.	1868	Nov. 23, 1880
WATSON, SERENO.	1889	Mar. 9, 1892
WHEELER, HENRY LORD.	1909 [2]	Oct. 30, 1914
WHITE, CHARLES A.	1880	June 29, 1910
WHITMAN, C. O.	1895	Dec. 6, 1910
WINLOCK, JOSEPH.	(1)	June 11, 1875
WOODWARD, J. J.	1873	Aug. 17, 1884
WORTHEN, A. H.	1872	May 6, 1888
WRIGHT, ARTHUR WILLIAMS.	1881 [2]	Dec. 19, 1915
WYMAN, JEFFRIES.	(1)	Sept. 4, 1874
YOUNG, CHARLES A.	1872	Jan. 3, 1908

[1] Charter members, March 3, 1863.

[2] Biographical notices have not been presented.

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DECEASED FOREIGN ASSOCIATES.

ADAMS, J. C.
AIRY, SIR GEORGE B.
ARGELANDER, F. W. A.
AUWERS, G. F. J. ARTHUR
BAER, KARL ERNEST VON
BARRANDE, JOACHIM
BEAUMONT, L. ÉLIE DE
BECQUEREL, HENRI
BERTHELOT, M. P. E.
BERTRAND, J. L. F.
BOLTZMANN, LUDWIG
BORNET, EDOUARD
BOUSSINGAULT, J. B. J. D.
BOVERI, THEODOR
BRAUN, ALEXANDER
BREWSTER, SIR DAVID
BUNSEN, ROBERT W.
BURMEISTER, C. H. C.
CANDOLLE, ALPHONSE DE
CAYLEY, ARTHUR
CHASLES, MICHEL
CHEVREUL, M. E.
CLAUSIUS, RUDOLPH
CORNU, ALFRED
DARWIN, SIR GEORGE HOWARD
DOVE, H. W.
DUMAS, J. B.
EHRLICH, PAUL
FARRADAY, MICHAEL
GEGENBAUR, KARL
GLYDÉN, HUGO
GILL, SIR DAVID
HAMILTON, SIR WILLIAM ROWAN
HELMHOLTZ, BARON H. VON
HOFF, J. H. VAN'T
HOFMANN, A. W.
HOOKER, SIR JOSEPH D.
HUGGINS, SIR WILLIAM
HUXLEY, T. H.
IBAÑEZ, CARLOS
JANSSEN, J.
JOULE, JAMES P.
KEKULÉ, AUGUST
KELVIN, LORD
KIRCHOFF, G. R.
KOCH, ROBERT
KOHLRAUSCH, FRIEDRICH
KÖLLIKER, ALBERT VON
KRONECKER, HUGO
LACAZE-DUTHIERS, HENRI DE
LEUCKART, RUDOLPH
LIE, SOPHUS
LIEBIG, JUSTUS VON
LISTER, LORD
LOEWY, MAURICE
LUDWIG, K. F. W.
MAREY, E. J.
MENDELÉEFF, D. I.
MILNE-EDWARDS, HENRI
MOISSAN, HENRI
MURCHISON, SIR RODERICK I.
MURRAY, SIR JOHN
OPPOLZER, THEODORE VON
OWEN, SIR RICHARD
PASTEUR, LOUIS
PETERS, C. A. F.
PLANA, G. A. A.
POINCARÉ, JULES HENRI
RAMMELSBERG, C. F.
REGNAULT, VICTOR
REYMOND, EMIL DU BOIS
RICHTHOFEN, F. VON
ROSENBUSCH, KARL HARRY FERDINAND
SACHS, JULIUS VON
SCHIAPARELLI, GIOVANNI
STAS, JEAN SERVAIS
STOKES, SIR GEORGE G.
STRASBURGER, EDOUARD
STRUVE, OTTO VON
SUESS, EDUARD
SYLVESTER, J. J.
TISSERAND, F. F.
VIRCHOW, RUDOLPH VON
VOGEL, H. C.
WEIERSTRASS, KARL
WEISMANN, AUGUST
WÖHLER, FRIEDRICH
WÜRTZ, ADOLPH
ZIRKEL, FERDINAND
ZITTEL, K. A. R. VON

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REPORT

OF THE

NATIONAL ACADEMY OF SCIENCES

FOR THE YEAR

1916

WASHINGTON
GOVERNMENT PRINTING OFFICE
1917

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SENATE RESOLUTION NO. 361.

[Reported by Mr. Chilton.]

IN THE SENATE OF THE UNITED STATES,
February 13, 1917.

Resolved, That the manuscript entitled "Report of the National Academy of Sciences for the year ended December 31, 1916," be printed as a Senate Document.

Attest:

JAMES M. BAKER,
Secretary.

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CONTENTS.

	Page.
Letter of transmittal	5
Act of incorporation	7
Amendments	8
Meetings of the National Academy, 1916	13
Annual meeting—	
Members in attendance	13
Business sessions	14
Announcement of deaths	14
Panama Canal slides	14
Reports of the president and treasurer	14
Report of the home secretary	14
Report of the foreign secretary	15
Report of the directors of the Bache fund	16
Report of the trustees of the Watson fund	17
Report of the committee on the Henry Draper fund	17
Report of the committee on the J. Lawrence Smith fund	18
Report of the directors of the Benjamin Apthorp Gould fund	18
Report of the trustees of the Wolcott Gibbs fund	19
Report of the committee on the Comstock fund	19
Report of the Committee on the Murray fund	19
Business from the council	20
Dues for 1916	20
Date for elections	20
International Association of Academies	20
Fiscal advisers of the academy	20
Autumn meeting	20
Sections	20
Engineers	20
Centigrade and Fahrenheit scales	20
Universal alphabet	20
Trust funds	21
Report of the editorial board of the Proceedings	21
Amendments to the constitution	22
National Research Council	22
Exhibit at meetings	22
Trust funds	22
Amendment to Rule IV	22
Committee on paleontologia universalis	23
American Academy of political and social science	23
Pacific exploration	23
Joseph A. Holmes Safety Association	23
Biographical memoirs	23
Cooperation with engineers	23
Centigrade and Fahrenheit scales	24
Election of foreign secretary	24
Election of new members of the council	24
Election of new members	25
Autumn meeting—time and place	25
Committee announcements	25
Presentation of medals, 1916	26

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Meetings of the National Academy, 1916—Continued.
Annual meeting—Continued.
Scientific sessions— Page.
April 17 ... 26
April 18 ... 28
April 19 ... 29
Autumn meeting ... 29
Members in attendance ... 29
Business sessions—
Announcement of deaths since annual meeting ... 29
Publications issued ... 29
Editorial board changes ... 29
Committee announcements ... 30
National Research Council ... 30
New members presented ... 30
Marsh fund ... 30
Section of engineering ... 30
Amendments to the constitution ... 30
Report of the National Research Council ... 31
Report of the committee on Panama Canal slides ... 36
Minutes ... 36
Proceedings ... 36
J. Lawrence Smith fund ... 36
Marsh fund ... 36
Report of the committee on the Medal for Eminence in the Application of Science to the Public Welfare ... 37
Biographical memoirs ... 37
Report of the committee on Synthetic Organic Chemistry ... 37
Scientific sessions—
November 13 ... 37
November 14 ... 38
Scientific exhibits ... 39
Henry Draper medalists ... 42
Deceased members:
Arthur Williams Wright ... 42
Josiah Royce ... 44
Eugene Woldemar Hilgard ... 50
Cleveland Abbe ... 52
Annual report of the treasurer:
General review of financial transactions ... 54
Statement of assets and liabilities ... 55
Condensed statement of receipts and expenditures ... 58
Accounts with individual funds ... 61
Report of auditing committee ... 66
Appendices:
Appendix A.—Constitution of the National Academy ... 69
Appendix B.—Rules ... 76
Appendix C.—Organization of the academy, 1916-17 ... 82
Sections ... 82
Standing committees ... 84
Trust funds ... 84
Members of the National Academy of Sciences, December 31, 1916 ... 87
Honorary member ... 90
Foreign associates ... 90
Deceased members ... 91
Deceased foreign associates ... 94

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LETTER OF TRANSMITTAL.

National Academy of Sciences,
January 27, 1917.

The Honorable Thomas R. Marshall,
Vice President of the United States,
Washington, D. C.

Sir: I have the honor to transmit to you herewith the annual report of the president of the National Academy of Sciences for the year ending December 31, 1916.

Very respectfully,

Arthur L. Day,
Home Secretary.

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ACT OF INCORPORATION.

AN ACT To incorporate the National Academy of Sciences.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That Louis Agassiz, Massachusetts; J. H. Alexander, Maryland; S. Alexander, New Jersey; A. D. Bache, at large; F. B. Barnard,[1] at large; J. G. Barnard, United States Army, Massachusetts; W. H. C. Bartlett, United States Military Academy, Missouri; U. A. Boyden,[2] Massachusetts; Alexis Caswell, Rhode Island; William Chauvenet, Missouri; J. H. C. Coffin, United States Naval Academy, Maine; J. A. Dahlgren,[2] United States Navy, Pennsylvania; J. D. Dana, Connecticut; Charles H. Davis, United States Navy, Massachusetts; George Engelmann, Saint Louis, Missouri; J. F. Frazer, Pennsylvania; Wolcott Gibbs, New York; J. M. Gilless,[3] United States Navy, District of Columbia; A. A. Gould, Massachusetts; B. A. Gould, Massachusetts; Asa Gray, Massachusetts; A. Guyot, New Jersey; James Hall, New York; Joseph Henry, at large; J. E. Hilgard, at large, Illinois; Edward Hitchcock, Massachusetts; J. S. Hubbard, United States Naval Observatory, Connecticut; A. A. Humphreys, United States Army, Pennsylvania; J. L. Le Conte, United States Army, Pennsylvania; J. Leidy, Pennsylvania; J. P. Lesley, Pennsylvania; M. F. Longstreth, Pennsylvania; D. H. Mahan, United States Military Academy, Virginia; J. S. Newberry, Ohio; H. A. Newton, Connecticut; Benjamin Peirce, Massachusetts; John Rodgers, United States Navy, Indiana; Fairman Rogers, Pennsylvania; R. E. Rogers, Pennsylvania; W. B. Rogers, Massachusetts; L. M. Rutherford, New York; Joseph Saxton, at large; Benjamin Silliman, Connecticut; Benjamin Silliman, junior, Connecticut; Theodore Strong, New Jersey; John Torrey, New York; J. G. Totten, United States Army, Connecticut; Joseph Winlock, United States Nautical Almanac, Kentucky; Jeffries Wyman, Massachusetts; J. D. Whitney, California; their associates and successors duly chosen, are hereby incorporated, constituted, and declared to be a body corporate, by the name of the National Academy of Sciences.

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[1] The official list of members gives the name of F. A. P. Barnard.
[2] Declined.
[3] The official list of members gives the name of J. M. Gillis.

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SEC. 2. *And be it further enacted*, That the National Academy of Sciences shall consist of not more than fifty ordinary members, and the said corporation hereby constituted shall have power to make its own organization, including its constitution, by-laws, and rules and regulations; to fill all vacancies created by death, resignation, or otherwise; to provide for the election of foreign and domestic members, the division into classes, and all other matters needful or usual in such institution, and to report the same to Congress.

SEC. 3. *And be it further enacted*, That the National Academy of Sciences shall hold an annual meeting at such place in the United States as may be designated, and the academy shall, whenever called upon by any department of the Government, investigate, examine, experiment, and report upon any subject of science or art, the actual expense of such investigations, examinations, experiments, and reports to be paid from appropriations which may be made for the purpose, but the academy shall receive no compensation whatever for any services to the Government of the United States.

Approved, March 3, 1863.

AMENDMENTS.

AN ACT To amend the act to incorporate the National Academy of Sciences.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the act to incorporate the National Academy of Sciences, approved March third, eighteen hundred and sixty-three, be, and the same is hereby, so amended as to remove the limitation of the number of ordinary members of said academy as provided in said act.

Approved, July 14, 1870.

AN ACT To authorize the National Academy of Sciences to receive and hold trust funds for the promotion of science, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the National Academy of Sciences, incorporated by the act of Congress, approved March third, eighteen hundred and sixty-three, and its several supplements, be, and the same is hereby, authorized and empowered to receive bequests and donations and hold the same in trust, to be applied by the said academy in aid of scientific investigations and according to the will of the donors.

Approved, June 20, 1884.

AN ACT To amend the act authorizing the National Academy of Sciences to receive and hold trust funds for the promotion of science, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the act to authorize the National Academy of Sciences to receive and hold

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trust funds for the promotion of science, and for other purposes, approved June twentieth, eighteen hundred and eighty-four, be, and the same is hereby, amended to read as follows:

"That the National Academy of Sciences, incorporated by the act of Congress approved March third, eighteen hundred and sixty-three, be, and the same is hereby, authorized and empowered to receive, by devise, bequest, donation, or otherwise, either real or personal property, and to hold the same absolutely or in trust, and to invest, reinvest, and manage the same in accordance with the provisions of its constitution, and to apply said property and the income arising therefrom to the objects of its creation and according to the instructions of the donors: *Provided, however*, That the Congress may at any time limit the amount of real estate which may be acquired and the length of time the same may be held by said National Academy of Sciences."

SEC. 2. That the right to alter, amend, or repeal this act is hereby expressly reserved.

Approved, May 27, 1914.

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ANNUAL REPORT

OF THE

NATIONAL ACADEMY OF SCIENCES.

During the past year two commissions have been given to the academy by the President of the United States, each of which bears very directly upon the public welfare. The first directed the academy to examine into the nature and consequences of the landslides which have blocked the passage of the Panama Canal from time to time; the second called upon the academy to take the initiative in ascertaining and correlating the resources for research (men, equipment, and experience) of the country, which may be applied to the solution of the scientific problems which are constantly arising just now in the preparations to meet impending national emergencies.

The examination of the canal slides was undertaken by a committee of 12 geologists and engineers, all men of national reputation, and their decision is of a kind to invite and to receive general attention at this time. Public confidence in the canal was rather seriously shaken when the great waterway remained closed to traffic for some months with no certainty that when cleared again it might not be closed by further slides within a few days or weeks. The strain upon shippers and upon the American public, which has taken an active interest and pride in the greatest engineering undertaking of our time, has been very severe.

The final report of the committee, though not yet in print, goes far to relieve this apprehension. The geologists of the academy committee assure us that there is no further ground for serious apprehension; that the mass of material in motion is now continually diminishing in magnitude, and although further slips are to be expected, they can not attain the volume of those that are past, nor can they any longer be accounted a serious menace to the full and complete usefulness of the canal in transporting the heaviest traffic from ocean to ocean.

The report of the committee will soon appear in print as a separate document.

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The second charge which was given to the academy is a direct consequence of a resolution taken at the annual meeting of the academy in April, 1916, as follows:

Resolved, That the President of the Academy be requested to inform the President of the United States that in the event of a break in diplomatic relations with any other country the academy desires to place itself at the disposal of the Government for any service within its scope.

When this resolution was brought to the attention of the President, he desired that the academy should take the initiative in ascertaining and correlating the scientific resources of the country which might be depended upon for the solution of problems arising out of the movement for "preparedness" against the possibility of war.

The council of the academy took immediate action upon the request and organized an independent body with power to act, which has been called the National Research Council. The explicit purposes of this research council as set forth in a prospectus recently issued are the following:

(1) The preparation of a national inventory of equipment for research, of the men engaged in it, and of the lines of investigation pursued in cooperating Government bureaus, educational institutions, research foundations, and industrial research laboratories—this inventory to be prepared in harmony with any general plan adopted by the Government Council of National Defense.

(2) The preparation of reports by special committees, leading to the statement of important research problems and thus serving as a clearing house for the coordination of research in various departments of science.

(3) The promotion of cooperation in research with the object of securing increased efficiency, but with careful avoidance of any hampering control or interference with individual freedom and initiative.

(4) Cooperation with educational institutions, by supporting their efforts to secure larger funds and more favorable conditions for the pursuit of research and for the training of students in the methods and spirit of investigation.

(5) Cooperation with research foundations and other agencies desiring to secure a more effective use of funds available for investigation.

(6) The encouragement in cooperating laboratories, of researches designed to strengthen the national defense and to render the United States independent of foreign sources of supply liable to be affected by war.

It is at once obvious that the value to the National Government of the information now being gathered in pursuit of this plan is very great, and there is a consequence which is by no means secondary in

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importance in the effect which its work has had in stimulating scientific activity throughout the country. Both educational institutions and industrial organizations are planning research work as never before.

It is still too early perhaps to appraise properly the ultimate scope or effect of the present effort, but it is certain to surpass all expectations, both in the amount of information which will become available to meet national needs and in the wonderful stimulus given to the movement for scientific investigation and research, not to mention the gain in efficiency in such studies through closer coordination than has been possible heretofore. A report of the activities of the council for the first year of its existence will be found on a later page (p. 31), together with a list of its members.

MEETINGS OF THE NATIONAL ACADEMY.

During the year 1916 the academy held two stated meetings, the annual meeting in April, at Washington, and the autumn meeting in November, at Boston, Mass.

ANNUAL MEETING.

The sessions were held in the United States National Museum and in the Oak Room of the Raleigh Hotel, Washington, D. C., April 17, 18, 19, 1916. Seventy-one members were present, as follows:

Abbot, Charles Greeley.
Allen, J. Asaph.
Ames, J. S.
Becker, George F.
Boltwood, B. B.
Britton, Nathaniel Lord.
Bumstead, Henry Andrews.
Campbell, D. H.
Cannon, Walter Bradford.
Cattell, James McKeen.
Clark, W. B.
Clarke, F. W.
Clarke, J. M.
Comstock, George C.
Conklin, E. G.
Coulter, J. M.
Cross, Whitman.
Dall, William H.
Davenport, C. B.
Davis, William Morris.
Day, Arthur L.
Donaldson, Henry Herbert.
Fewkes, Jesse Walter.
Flexner, Simon.
Hague, Arnold.
Hale, George E.
Hall, E. H.
Harper, R. A.
Hayford, John F.
Hillebrand, W. F.
Holmes, William H.
Howell, William H.
Iddings, Joseph.
Jennings, Herbert Spencer.
Leuschner, Armin O.
Lillie, Frank Rattray.
Loeb, Jacques.
Lusk, Graham.
Mall, F. P.
Meltzer, Samuel James.
Mendel, Lafayette B.
Merriam, C. Hart.
Merritt, Ernest.
Millikan, Robert Andrews.
Moore, Eliakim H.
Morley, Edward W.
Morse, H. N.
Moulton, F. R.

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Nichols, E. L.
Noyes, Arthur A.
Parker, George H.
Pickering, Edward C.
Pupin, M. I.
Ransome, Frederick Leslie.
Reid, H. Fielding.
Remsen, Ira.
Rosa, Edward B.
Schuchert, Charles.
Scott, William B.
Smith, Erwin F.
Story, William E.
Van Hise, C. R.
Van Vleck, E. B.
Walcott, Charles D.
Webster, Arthur G.
Welch, William H.
Wheeler, William M.
White, David.
White, H. S.
Wilson, Edmund B.
Wood, R. W.
Woodward, R. S.

BUSINESS SESSIONS.

ANNOUNCEMENT OF DEATHS.

The president announced the deaths since the autumn meeting of four members and two foreign associates:

Members.—John Ulric Nef, elected in 1904, died on August 13, 1915.

Frederick Ward Putnam, elected in 1885, died on August 18, 1915.

Arthur W. Wright, elected in 1881, died on December 19, 1915.

Eugene W. Hilgard, elected in 1872, died on January 8, 1916.

Foreign associate.—Paul Erhlich, elected in 1904, died on August 20, 1915.

The president announced that the preparation of biographical memoirs of deceased members had been assigned as follows: John Ulric Nef to J. O. Stieglitz, Frederick Ward Putnam to Jesse Walter Fewkes.

PANAMA CANAL SLIDES.

The president stated that a preliminary report of the committee to investigate the slides at the Panama Canal had been prepared and transmitted by him to the President of the United States and that the final report was in process of completion and would in turn be transmitted to the President of the United States. The preliminary report is printed in full in the proceedings of the academy.

REPORTS OF THE PRESIDENT AND THE TREASURER.

The reports of the president[1] and of the treasurer[2] for 1915, as transmitted to the Senate of the United States by the President of the Academy, were presented in their printed form and approved.

REPORT OF THE HOME SECRETARY.

The PRESIDENT OF THE NATIONAL ACADEMY OF SCIENCES.

SIR: I have the honor to present the following report on the publications and membership of the National Academy of Sciences for the year ending April 19, 1916.

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[1] Report of the National Academy of Sciences for the year 1915, pp. 11–30.
[2] Idem, pp. 36–45.

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The memoirs of the National Academy of Sciences, volume 12, part 2, entitled, "Variations and Ecological Distribution of the Snails of the Genus Io." by Charles C. Adams, has been published and distributed, as has also the memoir forming volume 13, entitled "A Catalogue of the Meteorites of North America," by Oliver C. Farrington. Volume 14, memoir 1, entitled, "Report on Researches on the Chemical and Mineralogical Composition of Meteorites, with Especial Reference to Their Minor Constituents," by George Perkins Merrill, is in press and the final proof has been passed. It awaits casting and printing before it is published.

The biographical memoirs of John W. Powell, Miers Fisher Longstreth, Charles Anthony Schott, Peter Lesley, Henry Morton, and Alfred Marshall Mayer have been published and distributed, and that of George William Hill, by Ernest W. Brown, is also published but has not been distributed.

Three members have died since the last Annual Meeting: John Ulric Nef, on August 13, 1915, elected in 1904; Frederick W. Putnam, on August 18, 1915, elected in 1885; Arthur W. Wright, on December 19, 1915, elected in 1881; and Eugene W. Hilgard, on January 8, 1916, elected in 1872.

One foreign associate, Paul Erhlich, died on August 20, 1915.

There are 139 active members on the membership list, 1 honorary member, and 39 foreign associates.

ARTHUR L. DAY, *Home Secretary.*

REPORT OF THE FOREIGN SECRETARY.

I have the honor to report on the work of the foreign secretary for the year ending April 19, 1916.

An attempt has been made, through correspondence with various academies and societies belonging to the International Association of Academies, to secure a partial continuance of some portions of the Association's work through the period of the war. Although international meetings are obviously not feasible, it was hoped that a temporary transfer of the functions of leading academy from Berlin to Amsterdam, as suggested by the former body, might serve a useful purpose. Unfortunately, however, certain difficulties of an insuperable nature prevented the proposed transfer, and no further steps can be taken at present.

It was suggested to the Amsterdam Academy by the foreign secretary, also acting in the capacity of secretary of a joint committee of the National Academy and the American Association, that the Accademia dei Lincei be requested to use its good offices to secure the continuation of the work of the Zoological Station at Naples. A favorable reply was received from the president of the Lincei, but the participation of Italy in the war has prevented Dr. Dohrn from retaining the direction of the station, which is now under an Italian administration.

At the request of the president of the Amsterdam Academy, who is also permanent secretary of the International Geodetic Association, the Secretary of State was asked by the academy to use his influence to secure the continued participation of the United States in the work of the association, and the maintenance of the international latitude station at Ukiah, Cal. Through the action of the Secretary of State, and the interest of Members of Congress, the necessary appropriations have been provided.

GEORGE E. HALE,
Foreign Secretary.

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REPORT OF THE DIRECTORS OF THE BACHE FUND.

Mr. Ira Remsen resigned as director of the fund at the annual meeting, 1915. The two remaining members of the committee chose Mr. Arthur G. Webster as the third member, and later the undersigned was elected chairman. Since the annual meeting the following appropriations have been made:

No. 187, to H. H. Lane, State University of Oklahoma, $500, for the purchase of apparatus to be used in a comparative study of the embryos and young of various mammals in order to determine, by physiological experimentation and morphological observations, the correlation between structure and function in the development of the special senses.

No. 188, to H. W. Norris, Grinnell College, $100, for assistance in the analysis of the cranial nerves of Coecilians (Herpele and Dermophis).

No. 189, to E. J. Werber, Woods Hole, $230, for assistance in experimental studies aiming at the control of defective and monstrous developments; (1) the effect of the toxic products of metabolism on the developing teleost egg; (2) the effect of experimentally produced diseases of parental metabolism on the offspring of mammals.

No. 190, to H. S. Jennings, Johns Hopkins University, $200, for assistance in the study of evolution in a unicellular animal multiplying by fission: heredity, variation, racial differentiation in *Difflugia*.

No. 191, to P. W. Bridgman, Harvard University, $500, for mechanical assistance in an investigation of various effects of high hydrostatic pressure, in particular the effect of pressure on electrical resistance of metals (continuation).

No. 192, to J. P. Iddings, Washington, D. C., $1,000, for apparatus and assistance in the microscopical and chemical investigation of igneous rocks for the purpose of extending knowledge regarding petrographical provinces and their bearings on the problem of isostasy.

No. 193, to C. A. Kofoid, University of California, $500, for assistance in securing animals in the Indian jungle and in their preparation for study in research on the intestinal protozoa.

No. 194, to R. A. Daly, Harvard University, $1,000, for the purchase of a thermograph of new design for determining temperatures in the deep sea.

No. 195, to R. W. Hegner, University of Michigan, $160, for assistance in the study of the history of the germ cells, especially in hermaphrodite animals in order to determine the visible changes that take place in their differentiation and the causes of these changes (continuation).

The following information has been received concerning earlier grants:

No. 183. A report has been received from C. G. Abbot, describing the successful operation of the apparatus constructed with this grant. This closes the record of this award.

No. 184. Papers have been published by P. W. Bridgman on work done with the aid of this grant as follows:

"Change of phase under pressure." Physical Review, n. s., VI, July and August, 1915.

"Polymorphic transformation of solids under pressure." Proceedings of the American Academy of Arts and Sciences, II, September, 1915.

This closes the record of this award.

The treasurer of the academy states, under date of April 7, 1916, that the Bache fund has on hand a cash income balance of $980.62, together with an invested income of $2,575.

EDWIN B. FROST,
Chairman.

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REPORT OF THE TRUSTEES OF THE WATSON FUND.

The balance of the income of the Watson fund, available for appropriation, on April 1, 1916, was $1,070.15. The undersigned accordingly recommend the following votes:

Resolved, That the sum of $500 from the income of the Watson fund be appropriated to Prof. John A. Miller, director of the Sproul Observatory, for measuring plates already taken for the determination of stellar parallaxes. (Grant No. 10.) This is a continuation of grant No. 10 awarded last year, A report of the work accomplished is inclosed.

Resolved, That the sum of $300 from the income of the Watson fund be appropriated to Prof. Herbert C. Wilson, director of the Goodsell Observatory, for measurements of the positions of asteroids on photographs already taken. (Grant No. 12.)

In each of these cases, material has already been collected whose preparation independently would involve a large expenditure. A relatively small sum will thus complete the work and secure the results for which the investigations were undertaken.

EDWARD C. PICKERING.
W. L. ELKIN.
E. B. FROST.

REPORT OF THE COMMITTEE ON THE HENRY DRAPER FUND.

Four members of the committee, without consulting the fifth member (Prof. Michelson), recommend that the Henry Draper gold medal be awarded to Prof. A. A. Michelson, of the University of Chicago, for his numerous and important contributions to spectroscopy and astronomical physics.

It is impossible in the brief space of this report even to enumerate Prof. Michelson's major services to science. These include the precise determination of the velocity of light; the well-known experiment (with Prof. Morley) on ether drift; the measurement of the absolute wave-length of light involved in his determination of the length of the standard meter; the measurement of tides in the body of the earth with new apparatus of extraordinary precision; and the invention of the interferometer, the echelon, and other instruments of prime importance to the student of light. He has also constructed a ruling machine yielding diffraction gratings of the longest size and the highest resolving power yet attained, and carried on a multiplicity of researches of wide range and fundamental significance.

The committee also recommends that a grant of $250 be made to Prof. Philip Fox, director of the Dearborn Observatory, of Northwestern University, Evanston, Ill., to apply toward the cost of a machine for measuring astronomical photographs.

Regarding previous grants from the Draper fund, the committee begs to report that the grant to Dr. C. G. Abbot has been expended for computer's services in an investigation which has established the variability of distribution of radiation along the sun's diameter. Grants to Messrs. Campbell, Mitchell, Stebbins, Schlesinger, respectively, for the construction of instruments or the prosecution of researches not yet completed.

GEORGE E. HALE,
Chairman.

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REPORT OF THE COMMITTEE ON THE J. LAWRENCE SMITH FUND.

The committee on the J. Lawrence Smith fund reports as follows:

No. 3. Edmund Otis Hovey, curator in the department of geology and invertebrate paleontology in the American Museum of Natural History, New York, received, in 1909, a grant of $400 to aid in the study of certain meteors. He has for some time been with an expedition to the Arctic regions, so that the work is not at the moment making progress.

No. 4. C. C. Trowbridge, professor of physics in Columbia University, New York, received in 1909 a grant of $400 in aid of his studies of the luminous trains which are produced by some meteors. A further grant of $1,000 in four annual installments was voted by the academy in 1912. Good progress has been made in the tabulation of all existing records of such luminous trains and in the preparation of illustrations of them, as well as in other directions. Owing to conditions in Europe, the last installment of $250, available a year ago, has not yet been called for.

No. 5. George P. Merrill, head curator in the department of geology in the United States National Museum, has received grants in 1910, 1911, and 1913, amounting to $800, to aid in verifying the occurrence in some meteors of certain rare elements. This work has been very successfully completed, abstracts of results obtained have been presented to the academy, and the final report forms pages 1–26 of the Memoirs of the Academy, Vol. 14, just issuing from the press, and closing the record of this grant.

No. 6. S. A. Mitchell, professor in the University of Virginia, University, Va., received in 1915 a grant of $500 to aid in securing observations of paths and of radiants of meteors and in computing orbits where observations are sufficient. Maps in aid of such observations have been placed at the service of volunteer observers, and nearly 5,000 observations of meteor paths have been secured. These observations, as well as a good number otherwise secured, have been discussed and have yielded some 139 parabolic orbits.

The committee is unanimous in recommending that a further grant of $300 be made to carry on this valuable work.

The J. Lawrence Smith fund now has a cash balance of income of $834.77, of which $250 is already appropriated, though not yet paid over. The cash income balance available is therefore $584.77. There is also an invested income balance of $1,532.50.

For the committee.

EDWARD W. MORLEY,
Chairman.

REPORT OF THE BOARD OF DIRECTORS OF THE BENJAMIN APTHORP GOULD FUND.

The directors of the Benjamin Apthorp Gould fund of the National Academy of Sciences have the honor to present the following report:

In 1914 a grant of $200 was made to Sidney D. Townley to assist him in making observations on variable stars at the Lick Observatory. Only half of the money was used during the year ending April, 1915, and the remainder was granted to him to be used for the same purpose in the year beginning April, 1915.

A grant of $200 was made to R. W. Wood for the purpose of assisting him in carrying on his work in the photography of celestial objects with monochromatic light.

A grant of $100 was made to A. Van Maanen for the purpose of securing assistance in reducing the proper motions of certain lists of stars.

A grant of $640 was made to Edwin B. Frost for the purpose of purchasing a machine for measuring parallax plates.

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A grant of $500 was made to A. H. Pfund in 1914, but was returned, together with the accumulated interest.

There is now a cash balance to the credit of the Gould fund of $113.92 and an invested income balance of $457.50.

F. R. MOULTON,
E. E. BARNARD,
R. S. WOODWARD,
Directors.

REPORT OF THE DIRECTORS OF THE WOLCOTT GIBBS FUND.

The directors of the Wolcott Gibbs fund for chemical research respectfully submit the following report for the year 1915 to 1916 to the National Academy of Sciences:

On April 29, 1915, President Ira Remsen resigned from the board to the great regret of his colleagues.

On May 18 Prof. T. W. Richards was elected to fill the vacancy caused by President Remsen's withdrawal.

Only one appropriation has been made from the income of the fund this year—a grant (No. 6) to Prof. Gregory P. Baxter, of Cambridge, of $300 to provide apparatus, especially of platinum and quartz, and materials for his researches on atomic weights and changes of volume during solution.

The unexpended income of the fund is $90.77.

Satisfactory reports have been received from holders of previous grants.

Grants 2 and 5: Prof. Mary E. Holmes has a paper in press on "The Electro-Deposition of Copper from the Ammoniacal Cyanide Electrotype." Progress has also been made in the study of the deposition of cadmium and its separation from other elements.

Grant 3: Prof. W. J. Hale has finished his work on the cyclopentadiopyridazine except for a few less important details. He hopes in June to have the paper ready for publication.

Grant 4: Prof. W. D. Harkins has determined the freezing point lowerings for 13 salts in aqueous solutions, 9 of which are cobaltammines; and has begun the study of mixtures of salts.

C. L. JACKSON,
EDGAR F. SMITH,
T. W. RICHARDS,
Directors.

APRIL 6, 1916.

REPORT OF THE COMMITTEE ON THE COMSTOCK FUND.

The committee on the Comstock fund begs to report that, according to the statement of the treasurer of the National Academy of Sciences, the total income from the fund now available is $1,661.32.

The next award will be made at the end of the five-year period specified in the bequest, i. e., at the annual meeting in April, 1918.

EDW. L. NICHOLS,
Chairman.

APRIL 18, 1916.

REPORT OF THE COMMITTEE ON THE MURRAY FUND.

The SECRETARY, NATIONAL ACADEMY OF SCIENCES.

SIR: The committee on the Sir John Murray fund has to report that the unusual expenses due to the designing and striking off of the Agassiz medal,

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as called for by the terms of the gift, has required all the early income. The committee deemed best not to touch the original fund, and the income from the fund was not sufficient to meet these expenses. All these expenses have now been met, but there is no cash balance and no invested income. This income has been applied to the payment of the amount advanced from the general fund, but from now on the interest from the fund will be applied as originally intended, for the striking off of the Agassiz medal and contributions to oceanography.

ARNOLD HAGUE,
Chairman.

BUSINESS FROM THE COUNCIL.

Recommendations adopted:

(*a*) That the annual dues for 1916 be $5.

(*b*) That the election of new members, foreign secretary, and two members of the council be held on Wednesday morning, April 19, 1916.

(*c*) That the treasurer be authorized to pay the annual subscription of 200 francs to the International Association of Academies. That the treasurer be directed to withhold this payment of dues to the International Association of Academies until advised by the foreign secretary that payment may properly be made.

(*d*) That the American Security & Trust Co., of Washington, D. C., and Spencer Trask & Co., of New York, be designated fiscal advisers of the academy for 1916 and 1917.

(*e*) That the time and place of the autumn meeting, 1916, be left to the president and home secretary with power.

(*f*) That the home secretary be requested to transmit the thanks of the academy to the Cosmos Club for the courtesies extended to the members of the academy during the annual meeting.

(*g*) That the members of the academy be permitted to choose the section with which they wish to be affiliated and that no one shall be a member of more than one section.

(*h*) That it is desirable that a section of engineering be developed which shall include men who have made original contributions to the science or art of engineering; that to this end the council suggests to the academy that the present section of physics and engineering be designated the section of physics, and that the council, under the authority granted by section 4, article 4, of the constitution, nominate to the academy, after inviting suggestions from the members of the academy, two or three engineers each year until such time as it shall seem advisable to establish a separate section of engineering, any engineer elected as the result of such nominations being in the meantime assigned to that one of the existing sections to which his work is most closely related.

(*i*) That the president be authorized to appoint a committee of three to investigate and present a written report at the business meeting on Wednesday, April 19, upon the bill H. R. 528, providing that the centigrade scale of temperature shall be the standard in United States publications and that the use of the Fahrenheit scale be discontinued after an appropriate interval.

(*j*) That in accordance with the request of the chairman of the Committee on Foreign Affairs of the House of Representatives a committee of the academy be appointed to prepare a report upon the joint resolution (H. J. Res. 99), "That the President be, and he is hereby, requested to ascertain the views of foreign Governments regarding the proposition to appoint an international commission to prepare a universal alphabet," and that the report be submitted to the President of the Academy, who in turn will transmit it to the chairman of the Com-

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mittee on Foreign Affairs of the House of Representatives, reporting his action in the matter at the next annual meeting of the academy.

(*k*) That following the suggestion of the chairman of the directorate of the Bache fund (Mr. Frost), the rule of rotation in the membership upon committees in charge of trust funds controlled by the academy be recommended for adoption by the self-perpetuating committees charged with similar duties, if found practicable.

REPORT OF THE BOARD OF EDITORS OF THE PROCEEDINGS.

The board of editors of the Proceedings reports to the academy that the 12 numbers of the Proceedings issued since its last annual report contain 157 original papers, the report of the annual and autumn meetings, notices of scientific memoirs, and the report of the Panama Canal committee. These numbers consist of 641 pages, an average of 53 pages per number and of about 4 pages per article. The papers are distributed among different sciences as follows: Mathematics, 17; astronomy, 37; physics, 11; chemistry, 12; geology, paleonotology, and mineralogy, 16; botany, 3; zoology, 13; genetics, 17; physiology, pathology, bacteriology, and biochemistry, 16; anthropology, 13; psychology, 2.

The universities or research laboratories that have contributed three or more papers are as follows: Carnegie Institution, 32 (divided as follows: Mount Wilson Solar Observatory, 22; nutrition laboratory, 4; marine biology, 3; terrestrial magnetism, 1; botanical research, 1; geophysical laboratory 1); University of California, 17; Harvard University, 16; Johns Hopkins University, 14; University of Chicago, 13; Yale University, 7; Rockefeller Institute, 7; Princeton University, 6; United States Geological Survey, 5; United States National Museum, 5; Station for Experimental Evolution, 4; University of Illinois, 3; American Museum of Natural History, 3.

The edition of the Proceedings was reduced from 3,000 to 2,200 copies with the issue of May, 1915, and it is to be further reduced to 1,700 copies with the issue of May, 1916, as the distribution of free copies in America is to be now entirely discontinued. At present about 900 copies are mailed to foreign exchanges and about 250 copies to members of the academy and other American subscribers.

The total expense incurred in connection with the Proceedings during the year 1915, representing approximately the cost of publication of the first volume, is shown by the report of the treasurer to be $4,300.67. Of this sum $2,977.37 was expended for printing and distributing, corresponding to a cost of $4.65 per page.

The board recommends that action be taken by the academy informing members and others presenting accounts of new researches at the academy meetings that they are expected to furnish to the home secretary at the time of the meeting a brief paper describing these researches in form suitable for publication in the Proceedings. The board also suggests that, in order to secure fuller circulation of the Proceedings in our universities, colleges, and research laboratories, members of the academy be requested to see that their own institutions subscribe to the Proceedings in case they have not already done so.

ARTHUR A. NOYES,
Chairman.

The report was accepted and the following minute adopted:

That members and others presenting accounts of their researches at meetings of the academy be expected to furnish the home secretary at the time of the meeting with a written description of such researches in form suitable for publication in the Proceedings.

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AMENDMENTS TO THE CONSTITUTION.

The following amendments to the constitution were reported from the council and considered by the academy in committee of the whole:

That article 3, section 1, line 3, of the constitution be amended by substituting the word "fourth" for "third" in the phrase "beginning on the third Monday in April."—(E. G. Conklin.)

Referred to the academy with favorable recommendation.

That the last sentence of section 5, article 4, of the constitution be stricken out.—(Ira Remsen.)

Referred to the academy with favorable recommendation.

ORGANIZATION OF THE SCIENTIFIC RESOURCES OF THE COUNTRY FOR NATIONAL SERVICE.

The following resolution recommended by the council was unanimously adopted:

Resolved, That the President of the Academy be requested to inform the President of the United States that in the event of a break in diplomatic relations with any other country the academy desires to place itself at the disposal of the Government for any service within its scope.

The council was empowered to organize the academy for the purpose of carrying out the resolution most effectively.

EXHIBITS AT MEETINGS.

The plan for an exhibit to be held in connection with the meetings from time to time as opportunity offers, and that such an exhibit be held at the autumn meeting if found practicable, was adopted.

TRUST FUNDS.

The suggestion of the chairman of the directorate of the Bache fund, proposing a form of report for grantees of research funds of the academy, was approved; and the home secretary was directed to bring this form to the attention of the chairmen of the trust funds of the academy and to supply copies for the use of the committees.

The form of application blank for aid from funds of the academy as now used by the directorate of the Bache fund was approved and the home secretary was authorized to provide a similar one for the use of the chairmen of the other funds of the academy.

AMENDMENT TO RULE IV.

The undersigned move that section 2 of Rule IV be amended by adding at the end of its second paragraph the following sentence:

"In order to secure an adequate number of nominations the chairman, when necessary, shall obtain by personal solicitation a fuller vote of his section or shall submit to the section a supplementary formal ballot"; and by substituting in the third paragraph for the words "this second ballot" the words "the formal ballots."

ARTHUR A. NOYES,
ARTHUR L. DAY.

Amendment adopted.

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REPORT OF THE COMMITTEE ON PALEONTOLOGIA UNIVERSALIS

At a meeting of the committee of the National Academy on the paleontologia universalis, held at the time of the recent New York meeting of the academy, it was voted to request the academy to discontinue this committee in view of the fact that present conditions do not encourage the undertaking of any international enterprise of this sort. As the academy had no business session subsequent to the action of this committee I transmit this action for your records.

JOHN M. CLARKE, *Chairman.*

DECEMBER 1, 1915.

The report of the committee was accepted and the committee discharged.

AMERICAN ACADEMY OF POLITICAL AND SOCIAL SCIENCE.

The invitation extended by the American Academy of Political and Social Science for the National Academy of Sciences to appoint delegates to the twentieth annual meeting of the American Academy, April 28 and 29, 1916, was accepted and three delegates were appointed: W. B. Scott, Edgar F. Smith, and Henry H. Donaldson.

PACIFIC EXPLORATION.

A committee of five was appointed to consider what can be done in Pacific exploration, to report at the next meeting. W. M. Davis, chairman; W. H. Dall, George E. Hale, E. G. Conklin, John F. Hayford.

JOSEPH A. HOLMES SAFETY ASSOCIATION.

Mr. David White presented a report as delegate of the National Academy of Sciences to the Joseph A. Holmes Safety Association. The report of progress was accepted and Mr. White was continued as the delegate of the academy.

BIOGRAPHICAL MEMOIRS.

Considering a plan to place the biographical memoirs of the academy where they would be of the greatest value, the following resolution was adopted:

That the academy favors the plan of distributing memoirs of deceased members to the members of national scientific societies corresponding to the sections of the academy to which the subject of the memoir belongs and requests the council to carry out the plan at its discretion.

COOPERATION WITH ENGINEERS.

The cooperation of engineers in the work of the academy for the national welfare was considered, and the following resolution adopted:

The council recommends to the academy the appointment of a committee to discuss possible plans of cooperation with a committee of engineers.

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The committee on the part of the academy was constituted as follows: George E. Hale, chairman; Robert S. Woodward, M. I. Pupin, C. R. Van Hise, C. D. Walcott, Elihu Thomson, John F. Hayford, E. L. Nichols, E. B. Rosa, and J. S. Ames.

CENTIGRADE AND FAHRENHEIT SCALES.

Mr. C. G. Abbot, chairman of the committee appointed to report on the bill (H. R. 528) substituting the centigrade for the Fahrenheit thermometer scale in Government publications presented the following report, which was accepted:

Your committee for the consideration of bill H. R. 528, consisting of Messrs. C. G. Abbot, S. W. Stratton, and C. F. Marvin, unanimously reports the following resolution and moves its adoption:

The National Academy of Sciences shares the desire of scientific men in general for international and world-wide uniformity in units of measurement of all kinds, and with this object in view it favors the introduction of the centigrade scale of temperature, and units of the metric system generally, as standards in the publications of the United States Government.

It must be recognized that considerable initial expense must be incurred by the United States Weather Bureau in changing its apparatus to conform to the proposed act. Furthermore, on account of the more open scale of the centigrade system that bureau will be subject to a continued increased cost of publication, owing to the neeessity of printing the first decimal place in order to maintain the present accuracy. The use of negative temperatures and minus signs entails greater liability to errors, and more clerical labor would be required in checking the accuracy of the reports of cooperative observers of the Weather Bureau, and in computing monthly and other mean temperatures.

Notwithstanding the foregoing, the academy is in favor of legislation to make the centigrade scale of temperatures the standard in publications of the United States Government, and funds should be made available by Congress to accomplish the desired result.

The academy favors bill H. R. 528, "To discontinue the use of the Fahrenheit thermometer scale in Government publications," but recommends that it be amended by the addition of the following:

"SEC. 4. When in the publication of tables containing several meteorological and climatic elements, the use of data in centigrade temperatures leads to manifest incongruities, the Chief of the Weather Bureau is directed to publish related data in such units as are necessary to make the tables homogeneous and to secure international uniformity as far as practicable.

"SEC. 5. Nothing in this act shall prevent the use of the absolute centigrade scale of temperature in publications of the Government."

ELECTION OF FOREIGN SECRETARY.

Mr. George E. Hale was elected foreign secretary for a period of six years to succeed himself.

ELECTION OF TWO MEMBERS OF THE COUNCIL.

Mr. Russell H. Chittenden was elected to the council to succeed himself, and Mr. M. I. Pupin was elected for a period of three years.

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ELECTION OF MEMBERS.

The following new members were elected:

Gilbert Ames Bliss, mathematician, University of Chicago, Chicago, Ill.

Frank Schlesinger, astronomer, University of Pittsburgh, Pittsburgh, Pa.

Gregory Paul Baxter, chemist, Harvard University, Cambridge, Mass.

Marston Taylor Bogert, chemist, Columbia University, New York City.

Leland Ossian Howard, entomologist, United States Department of Agriculture, Washington, D. C.

Alfred Goldsborough Mayer, zoologist, Carnegie Institution, Tortugas, Fla.

Raymond Pearl, genetics, Maine Agricultural Experiment Station, Orono, Me.

Phoebus Aaron Theodor Levene, chemist, Rockefeller Institute of Medical Research, New York City.

Otto Folin, chemist, Harvard Medical School, Boston, Mass.

AUTUMN MEETING.

The president stated that the invitation of the members of the academy in Boston and vicinity to hold the autumn meeting in Boston on November 13, 14, 15, 1916, had been accepted.

COMMITTEE ANNOUNCEMENTS.

The president announced the following appointments to fill committee vacancies:

On program: J. McK. Cattell, 1919, to succeed himself.

TRUST FUNDS.

Henry Draper fund: Charles G. Abbot, 1921, in place of J. Trowbridge; W. W. Campbell, to serve as chairman.

J. Lawrence Smith fund: R. W. Wood, 1921, to succeed Ira Remsen.

Comstock fund: R. A. Millikan, 1921, to succeed Henry Crew.

Murray fund: W. M. Davis, 1919, in place of Arnold Hague; W. H. Dall, to be chairman.

Marcellus Hartley fund: W. H. Welch, term expires and vacancy not filled. Committee to consist of the remaining six members, two to retire each year. Assignments: G. F. Becker and W. F. Hillebrand, 1919; H. F. Osborn and M. I. Pupin, 1918; A. G. Webster and Theobald Smith, 1917.

Marsh fund.—E. H. Moore, 1919; C. Schuchert, 1918; E. S. Dana, 1917.

Watson fund: G. C. Comstock to succeed E. C. Pickering, resigned. E. B. Frost designated chairman of the trustees of the Watson fund.

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COMMITTEES.

Local committee, autumn meeting.—William M. Davis, chairman; E. C. Pickering, W. T. Councilman, George H. Parker, Arthur A. Noyes.

Pacific exploration.—W. M. Davis, chairman; George E. Hale, W. H. Dall, E. G. Conklin, John F. Hayford.

Cooperation with the engineering societies.—George E. Hale, chairman; R. S. Woodward, M. I. Pupin, C. R. Van Hise, C. D. Walcott, Elihu Thomson, John F. Hayford, E. L. Nichols, E. B. Rosa, J. S. Ames.

Universal alphabet.—J. McK. Cattell, chairman; A. Graham Bell, John Dewey, Waldemar Lindgren, Franz Boas.

Centigrade scale.—C. G. Abbot, chairman; C. F. Marvin, S. W. Stratton.

PRESENTATION OF MEDALS.

At the annual dinner of the academy, held at the Hotel Raleigh on April 18, 1916, the following medals were awarded:

WATSON MEDAL.

The Watson medal and honorarium provided by the Watson fund: To Armin Otto Leuschner for the skill and ability shown in supervising the preparation of tables of the Watson asteroids, involving original methods, and leading to results of value to celestial mechanics.

MEDAL FOR EMINENCE IN THE APPLICATION OF SCIENCE TO THE PUBLIC WELFARE.

The medal for eminence in the application of science to the public welfare provided by the Marcellus Hartley fund: To Cleveland Abbe for distinguished public service in establishing and organizing the Weather Service of the United States.

To Gifford Pinchot for distinguished public service in organizing and directing the movement for the systematic conservation of the natural resources of the United States.

SCIENTIFIC SESSIONS.

Meeting of April 17–19, 1916.

Monday, April 17.

MORNING SESSION.

S. J. MELTZER: On permeability of endothelia. (10 minutes.)

I. S. KLEINER and S. J. MELTZER: The influence of morphin upon the elimination of intravenously injected dextrose. (10 minutes.)

JACQUES LOEB: The sex of a parthenogenetic frog. (10 minutes.)

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SIMON FLEXNER: Finer mechanisms of protection from infection. (10 minutes.)

EDMUND B. WILSON: The distribution of the chondrisomes to the spermatozoa in scorpions. (15 minutes.)

VICTOR C. VAUGHAN: Further studies of the protein poison. (10 minutes.)

SYMPOSIUM ON THE EXPLORATION OF THE PACIFIC.

Arranged by W. M. Davis.

(By invitation of the program committee.)

W. M. DAVIS: On exploration of the Pacific. (20 minutes.)

J. F. HAYFORD: The importance of gravity observations at sea in the Pacific. (15 minutes.)

L. J. BRIGGS, President of the Philosophical Society of Washington: A new method of determining gravity at sea. (10 minutes.)

C. SCHUCHERT: The problem of continental fracturing and diastrophism in Oceanica. (12 minutes.)

J. P. IDDINGS: Petrological problems in the Pacific. (15 minutes.)

AFTERNOON SESSION.

ARTHUR KEITH (introduced by George F. Becker): A new form of metamorphism. (10 minutes.)

J. P. IDDINGS and E. W. MORLEY: Contributions to the petrology of Japan, Philippine Islands and the Dutch Indies. (10 minutes.)

SYMPOSIUM ON THE EXPLORATION OF THE PACIFIC.

(Continued from the morning session.)

G. W. LITTLEHALES, hydrographic engineer United States Hydrographic Office: The extent of knowledge of the oceanography of the Pacific. (15 minutes.)

C. F. MARVIN, Chief of the United States Weather Bureau: Marine meteorology and the general circulation of the atmosphere. (15 minutes.)

WM. H. DALL: On the distribution of Pacific invertebrates. (15 minutes.)

H. A. PILSBRY, Academy of Natural Sciences of Philadelphia: Land mollusca of the Pacific. (15 minutes.)

W. G. FARLOW: Marine algae of the Pacific. (15 minutes.)

D. H. CAMPBELL: Problems of the Pacific floras. (15 minutes.)

J. W. FEWKES: The Pacific as a field for anthropological investigation. (15 minutes.)

PAPERS OF THE REGULAR PROGRAM.

CHARLES R. STOCKARD, professor of anatomy, Cornell University Medical College, New York City: Hereditary transmission of defects resulting from alcoholism. (30 minutes.) (By invitation of the program committee.)

W. B. CANNON: Recent observations on the activity of some glands of internal secretion. (30 minutes.)

H. H. DONALDSON: Studies in the water content of the nervous system. (20 minutes.)

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EVENING SESSION.

First William Ellery Hale lecture, by Henry Fairfield Osborn, president of the American Museum of Natural History. Subject: The origin and evolution of life on the earth. (Illustrated.)

The lecture was followed by a conversazione in the art gallery of the museum.

Tuesday, April 18.

MORNING SESSION.

GEORGE E. HALE: Some recent results of solar research. (10 minutes.)

CHARLES E. ST. JOHN (introduced by G. E. Hale): An investigation of the suggested mutual repulsion of Fraunhofer lines. (10 minutes.)

ARTHUR S. KING (introduced by G. E. Hale): Anomalous dispersion phenomena in electric furnace spectra. (10 minutes.)

WALTER S. ADAMS (introduced by G. E. Hale): Illustrations of the new spectroscopic method of measuring stellar distances. (10 minutes.)

HARLOW SHAPLEY (introduced by G. E. Hale): Some results with the new 10-inch photographic telescope. (10 minutes.)

C. G. ABBOTT and L. B. ALDRICH: The pyranometer, an instrument for the measurement of sky radiation. (10 minutes.)

G. C. COMSTOCK: Invisible companions of binary stars. (10 minutes.)

EDWIN H. HALL: Theory of electric conduction in metals. (10 minutes.)

F. R. MOULTON: The evolution of the stars. (30 minutes.)

A. O. LEUSCHNER, Watson medallist: The minor planets discovered by James C. Watson. (20 minutes.)

AFTERNOON SESSION.

WM. H. DALL: Biography of Prof. Theodore Nicholas Gill (by title).

W. W. CAMPBELL: Biography of Prof. Edward Singleton Holden (by title).

W. W. CAMPBELL: Biography of Prof. Simon Newcomb (by title).

Report of the work of the committee upon the Panama Canal slides, by CHARLES R. VAN HISE, chairman. (30 minutes.)

H. FIELDING REID: The mechanics of the Panama slides. (20 minutes.)

THEODORE LYMAN, director Jefferson Physical Laboratory, Harvard University: The present state of knowledge of the extreme ultra-violet. (30 minutes.) (By invitation of the program committee.)

ROBERT A. MILLIKAN: A redetermination of e and N. (20 minutes.)

CARL L. ALSBERG, Chief of the Bureau of Chemistry, United States Department of Agriculture: The relation of investigational work to the enforcement of the food and drugs act. (30 minutes.) (By invitation of the program committee.)

J. WALTER FEWKES: Recent exploration of the Mesa Verde National Park, Colorado. (20 minutes.)

ERWIN F. SMITH: Further evidence on the nature of crown gall and cancer and that cancer in plants offers strong presumptive evidence both of the parasitic origin and of the essential unity of the various forms of cancer in man and animals. (60 minutes.)

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Wednesday, April 19.

AFTERNOON SESSION.

Second William Ellery Hale lecture, by Henry Fairfield Osborn, president of the American Museum of Natural History. Subject: The origin and evolution of life on the earth. (Illustrated.)

AUTUMN MEETING.

The autumn meeting of the academy was held at the Massachusetts Institute of Technology, Cambridge, Mass., on November 13, 14, 15, 1916.

Seventy-one members were present as follows: Abbot (C. G.), Abbot (H. L.), Barus, Baxter, Becker, Boas, Bogert, Boltwood, Bumstead, Cannon, Castle, Cattell, Chittenden, Clark (W. B.), Clarke (J. M.), Comstock, Conklin, Councilman, Crafts, Crew, Cross, Davenport, Davis, Day, Farlow, Fewkes, Folin, Goodale, Hale, Hall, Harper, Harrison, Hayford, Holmes, Howard, Howell, Iddings, Jackson, Leuschner, Lewis, Lindgren, Lusk, Mall, Mark, Mayer, Meltzer, Mendel, Michelson, Morley, Morse, Noyes, Osborn, Osborne, Parker, Pearl, Pickering, Prudden, Reid, Richards, Rosa, Scott, Story, Thomson, Van Hise, Walcott, Webster, Welch, Wheeler, White (David), Wilson, Wood (R. W.).

BUSINESS SESSION.

The home secretary made the following announcements:

DEATHS SINCE THE ANNUAL MEETING.

Members.—Cleveland Abbe, elected 1879, died October 28, 1916; Josiah Royce, elected 1906, died September 14, 1916.

Foreign Associate.—Sir William Ramsay, elected 1904, died July 24, 1916.

PUBLICATIONS ISSUED SINCE THE LAST ANNUAL MEETING.

Proceedings, volume 2, numbers 5–11.

Memoirs, volume 14, first memoir: George P. Merrill: Report on researches on the chemical and mineralogical composition of meteorites, with especial reference to their minor constituents.

Biographical Memoirs: George William Hill, by Ernest W. Brown; Theodore N. Gill, by William H. Dall.

CHANGES IN THE EDITORIAL BOARD OF THE PROCEEDINGS.

Raymond Pearl, chairman, in place of A. A. Noyes.

Retiring December 1, 1916: W. B. Cannon, J. McK. Cattell, J. M. Coulter, Simon Flexner, R. G. Harrison.

Appointed in 1916: A. G. Mayer, H. H. Donaldson, Graham Lusk, R. A. Harper, A. A. Noyes.

E. B. Wilson, managing editor, reappointed.

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COMMITTEE ANNOUNCEMENTS.

Auditing Committee.—William H. Dall, F. W. Clarke, Arthur L. Day.

Committee on the Organization of the Scientific Resources of the Country for National Service.—G. E. Hale, chairman; E. G. Conklin, Simon Flexner, R. A. Millikan, A. A. Noyes.

Joint Committee with American Chemical Society on Synthetic Organic Chemistry.—M. T. Bogert, chairman.

Committee on Nitric Acid Supply.—Arthur A. Noyes, chairman; Gano Dunn, Warren K. Lewis,[1] Theodore W. Richards, Leo H. Baekeland,[1] Charles N. Herty,[1] Michael I. Pupin, Elihu Thomson, Willis R. Whitney.[1]

NATIONAL RESEARCH COUNCIL.

The president announced that he had forwarded a preliminary report on the National Research Council to the President of the United States.

NEW MEMBERS.

The following new members were presented to the academy: Marston Bogert, L. O. Howard, A. G. Mayer, Raymond Pearl.

MARSH FUND.

The treasurer reported that notice had been received from the attorneys for Mr. W. W. Farnam, the executor of the estate of Othniel C. Marsh, that he had filed in the New Haven probate court a supplemental account as executor which showed a balance of interest due the academy of $6,921.84.

SECTION OF ENGINEERING.

The following resolution presented by the council and adopted at the business session of the academy on April 17, 1916, was considered:

> That the council express to the academy the opinion that it is desirable that a section of engineering be developed which shall include men who have made original contributions to the science or art of engineering; that to this end the council suggests to the academy that the present section of physics and engineering be designated the section of physics, and that the council, under the authority granted by section 4, article 4, of the constitution, nominate to the academy, after inviting suggestions from the members of the academy, two or three engineers each year until such time as it shall seem advisable to establish a separate section of engineering, any engineers elected as the result of such nominations being in the meantime assigned to that one of the existing sections to which their work is most closely related.

The home secretary was authorized to send a copy of the above resolution to each member.

[1] Named by the American Chemical Society.

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AMENDMENTS TO THE CONSTITUTION.

The following amendments to the constitution, reported from the council and returned to the academy from the committee of the whole with favorable recommendation, were considered:

That article 3, section 1, line 3, of the constitution be amended by substituting the word "fourth" for "third" in the phrase "beginning on the third Monday in April."

Amendment lost.

That the last sentence of section 5, article 4, of the constitution be stricken out.

Amendment adopted.

The following new amendment to the constitution was offered:

Moved: That Article III, section 1, be amended by striking out the words "beginning on the third Monday in April" and inserting after the word "meeting" in the third line the word "both" and adding at the end of the section the words "*Provided*, That the annual meeting shall be held in April" so as to read:

"ARTICLE III, SECTION 1. The academy shall hold one stated meeting in each year, called the annual meeting, in the city of Washington, and another, called the autumn meeting, both to be held at such place and time as the council shall determine, provided that the annual meeting shall be held in April."

CHARLES R. VAN HISE.
CHARLES D. WALCOTT.

Amendment referred to the council.

REPORT OF THE NATIONAL RESEARCH COUNCIL.

On April 19, 1916, at the closing session of the annual meeting, the academy voted unanimously to offer its services to the President of the United States in the interest of national preparedness. The council of the academy was authorized to execute the work in the event of the President's acceptance.

On April 26 the President of the Academy, accompanied by Messrs. Conklin, Hale, Walcott, and Woodward, was received at the White House by the President of the United States. In presenting the resolution adopted at the annual meeting, it was suggested that the academy might advantageously organize the scientific resources of educational and research institutions in the interest of national security and welfare. The President accepted this offer, and requested the academy to proceed at once to carry it into effect.

Immediately following this visit, the President of the Academy, in harmony with resolutions adopted by the council on April 19, appointed the following organizing committee: Messrs. Edwin G. Conklin, Simon Flexner, Robert A. Millikan, Arthur A. Noyes, and George E. Hale (chairman). This committee, after obtaining assurances of cooperation from members of the Cabinet, national scientific and engineering societies, the committee of physicians, scientific bureaus of the Government, research foundations, educational institutions, industrial research laboratories, and many leading investigators, and after organizing a committee on nitrate supply (A. A. Noyes, chairman) at the request of the Secretary of War, prepared a general plan of procedure, which was presented to the council of the academy on June 19.

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It was recognized from the outset that the work to be undertaken should not be confined to the promotion of researches bearing directly upon military problems, but that true preparedness would best result from the encouragement of every form of investigation, whether for military and industrial application or for the advancement of knowledge without regard to its immediate practical bearing. The scheme of organization must be broad enough to secure the cooperation of all important agencies in accomplishing this result.

The plan submitted, which has been published in full in the Proceedings of the academy (vol. 2, p. 508), called for the formation of a National Research Council, the purpose of which shall be to bring into cooperation governmental, educational, industrial, and other research organizations with the object of encouraging the investigation of natural phenomena, the increased use of scientific research in the development of American industries, the employment of scientific methods in strengthening the national defense, and such other applications of science as will promote the national security and welfare.

It was also recommended that the council be composed of leading American investigators and engineers, representing the Army, Navy, Smithsonian Institution, and various scientific bureaus of the Government, educational institutions and research endowments, and the research divisions of industrial and manufacturing establishments.

The council of the academy voted to accept the proposals of the organizing committee, and instructed it to proceed with the formation of the National Research Council in accordance with the plan recommended by the committee.

The indorsement of the President of the United States and his willingness to appoint Government representatives was expressed in the following letter to the President of the Academy:

"WASHINGTON, D. C., *July 24, 1916.*

"DR. WILLIAM H. WELCH,

"*President of the National Academy of Sciences, Baltimore, Md.*

"MY DEAR DR. WELCH: I want to tell you with what gratification I have received the preliminary report of the National Research Council, which was formed at my request under the National Academy of Sciences. The outline of work there set forth and the evidences of remarkable progress toward the accomplishment of the object of the council are indeed gratifying. May I not take this occasion to say that the departments of the Government are ready to cooperate in every way that may be required, and that the heads of the departments most immediately concerned are now, at my request, actively engaged in considering the best methods of cooperation?

"Representatives of Government bureaus will be appointed as members of the Research Council as the council desires.

"Cordially and sincerely yours,

"WOODROW WILSON."

On August 5, with the assent of the heads of the several executive departments, the President appointed certain representatives of the Army and Navy and of various scientific bureaus of the Government as members of the National Research Council, with the understanding that others would be appointed as the development of the work might require. The remaining members of the council were appointed by the President of the National Academy, after consultation with the presidents of various national scientific and engineering societies (enumerated in the Proceedings, 607, loc. cit.).

The President of the Academy and the chairman of the organizing committee then sailed for Europe for the purpose of studying the organization and applications of science in field and laboratory under war conditions. The informa-

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tion thus acquired is being utilized in the work of the council, which held its first meeting on September 20.

As the minutes of this meeting and of the subsequent meetings of the executive committee have been fully reported in the Proceedings, it is unnecessary to give them here. One instance of the cordial cooperation experienced on every hand must be cited, however, because of its fundamental significance in the organization of the council.

At its annual meeting on June 21 the Engineering Foundation of New York, which is conducted under the auspices of the four great national engineering societies, adopted the following resolutions:

"Whereas, the National Academy of Sciences of the United States of America has taken the initiative in bringing into cooperation existing governmental, educational, industrial, and other research organizations, with the object of encouraging the investigation of natural phenomena, the application of scientific principles in American industries, the employment of science in the national defense, and such other objects as will promote the national welfare, and

"Whereas, these objects are among the objects for which the Engineering Foundation was created; now, therefore, be it

"*Resolved*, That the Engineering Foundation hereby registers its approval of the coordination and federation of the research agencies of the country undertaken by the National Academy of Sciences and expresses its willingness to join with and assist the National Academy in accomplishing the above federation."

The foundation also voted to devote its entire income for the current year (including a special gift of $5,000 for this purpose from its founder, Mr. Ambrose Swasey) toward the expenses of organization, to give the services of its secretary, Dr. Cary T. Hutchinson, and to provide a New York office for the council in the Engineering Societies' Building.

Similar resolutions of indorsement and cooperation have been adopted by the American Philosophical Society, the Marine Biological Laboratory at Woods Hole, the American Physical Society, the American Institute of Consulting Engineers, the Franklin Institute, the Zoological Society of America, the American Society of Naturalists, the Geological Society of America, the Association of American Geographers, the Association of American Anatomists, and many other societies and institutions.

As President Wilson especially requested the academy to secure the cooperation and joint effort of the various research agencies of the country, the participation of the Committee of One Hundred on Scientific Research of the American Association for the Advancement of Science was especially desired. A joint committee, representing the American association and the National Research Council, was appointed to consider plans of cooperation. It presented a report at the meeting of the Committee of One Hundred, held in New York on December 26, 1916, which then

"*Resolved*, That the Committee of One Hundred on Scientific Research of the American Association for the Advancement of Science cooperate with the National Research Council in those research movements in which both organizations are interested; and especially, in order to avoid duplication of effort that might arise from individual action of the two groups of committees which have already been appointed in the different sciences, that the Committee of One Hundred of the Association cooperate with the National Academy of Sciences and the national scientific societies in the formation of single committees in the various branches of science.

88121°—S. Doc. 707, 64-2——3

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That in order to effect the cooperation provided by the preceding vote the Committee of One Hundred on research designate through its chairman members of the Association to serve as members of the research committees of the National Research Council devoted to the various branches of science. with the understanding that these committees shall consist of members designated in equal or approximately equal numbers by the association, the National Academy of Sciences, and the national scientific society representing the branch of research involved.

After discussion this motion was carried.

The officers and members of the National Research Council are:

OFFICERS.

Chairman, George E. Hale.
First vice chairman, Charles D. Walcott.
Second vice chairman, Gano Dunn.
Chairman of executive committee, J. J. Carty.
Secretary, Cary T. Hutchinson.

EXECUTIVE COMMITTEE.

1. William H. Welch,[1] President, National Academy of Sciences.
2. George E. Hale,[1] Director, Mount Wilson Solar Observatory.
3. C. D. Walcott,[1] Secretary, Smithsonian Institution.
4. Gano Dunn,[1] President, J. G. White Engineering Corporation.
5. J. J. Carty, Chief Engineer, American Telephone & Telegraph Co.
6. Russell H. Chittenden, Director, Sheffield Scientific School, Yale University.
7. Edwin G. Conklin, Professor of Zoology, Princeton University.
8. Robert A. Millikan, Professor of Physics, University of Chicago.
9. Arthur A. Noyes, Professor of Physical Chemistry, Massachusetts Institute of Technology.
10. Raymond Pearl, Biologist, Maine Agricultural Experiment Station.
11. M. I. Pupin, Professor of Electromechanics, Columbia University.
12. S. W. Stratton, Director, Bureau of Standards.
13. Victor C. Vaughan, Director, Medical Research Laboratory, University of Michigan.

MEMBERS.

Leo H. Baekeland, Past President, American Electrochemical Society.
Marston T. Bogert, Professor of Organic Chemistry, Columbia University.
John A. Brashear, Past President, American Society of Mechanical Engineers.
W. B. Cannon, Harvard Medical School.
John J. Carty, Chief Engineer, American Telephone & Telegraph Co.
Russell H. Chittenden, Director, Sheffield Scientific School.
John M. Clarke, State Geologist, Albany, N. Y.
Howard E. Coffin, Member Advisory Commission to Council of National Defense.
Edwin G. Conklin, Professor of Zoology, Princeton University.
John M. Coulter, Professor of Botany. University of Chicago.
William Crozier, Chief of Ordnance, United States Army.
W. M. Davis, Harvard University.
Gano Dunn, President, J. G. White Engineering Corporation.
Simon Flexner, Director, Rockefeller Medical Institute.
James D. Gatewood, Medical Director, Naval Medical School.

[1] Members ex officio.

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William C. Gorgas, Surgeon General, United States Army.
W. F. M. Goss, Dean of Engineering, University of Illinois.
Robert S. Griffin, Engineer in Chief, United States Navy.
George E. Hale, Director, Mount Wilson Solar Observatory.
Clemens Herschel, President, American Society of Civil Engineers.
William H. Holmes, Curator, United States National Museum.
W. W. Keen, President, American Philosophical Society.
Van H. Manning, Director, Bureau of Mines.
Franklin H. Martin, Member Advisory Commission to Council of National Defense.
Charles F. Marvin, Chief, United States Weather Bureau.
A. A. Michelson, Director, Ryerson Physical Laboratory, University of Chicago.
Robert A. Millikan, Professor of Physics, University of Chicago.
Arthur A. Noyes, Director, Research Laboratory of Physical Chemistry, Massachusetts Institute of Technology.
Raymond Pearl, Biologist, Maine Agricultural Experiment Station.
E. C. Pickering, Director, Harvard College Observatory.
Michael I. Pupin, Professor of Electromechanics, Columbia University.
Charles F. Rand, President, United Engineering Society.
Theodore W. Richards, Director, Wolcott Gibbs Memorial Laboratory, Harvard University.
C. E. Skinner, Engineer of Research Division, Westinghouse E. & M. Co.
George O. Squier, Chief of Aviation, United States Army.
S. W. Stratton, Director, Bureau of Standards.
Ambrose Swasey, Past President, American Society of Mechanical Engineers.
David W. Taylor, Chief Constructor, United States Navy.
Elihu Thomson, Past President, American Institute of Electrical Engineers.
C. R. Van Hise, President, American Association for the Advancement of Science.
Victor C. Vaughan, Director, Medical Research Laboratory, University of Michigan.
Charles D. Walcott, Secretary, Smithsonian Institution.
William H. Welch, President, National Academy of Sciences.
W. R. Whitney, Director, Research Laboratory, General Electric Co.

The principal committees hitherto established by the Research Council are as follows:

I. Military committee (for governmental research requirements):
- Charles D. Walcott, chairman, Secretary, Smithsonian Institution.
- S. W. Stratton, secretary, Director, Bureau of Standards.
- From the Army—
  - William C. Gorgas, Surgeon General, United States Army.
  - William Crozier, Chief of Ordnance, United States Army.
  - George O. Squier, Chief of Aviation, United States Army.
- From the Navy—
  - David W. Taylor, Chief Constructor, United States Navy.
  - Robert S. Griffin, Engineer in Chief, United States Navy.
  - James D. Gatewood, Medical Director, Naval Medical School.
- Charles F. Marvin, Chief, Weather Bureau.
- Van H. Manning, Director, Bureau of Mines.
- Howard E. Coffin, of Council of National Defense.

II. Research in educational institutions: George E. Hale, chairman.

III. Promotion of industrial research: J. J. Carty, chairman.

IV. Census of research: S. W. Stratton, chairman.

V. Chemistry: Marston T. Bogert, chairman.

VI. Physics: R. A. Millikan, chairman.

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VII. Astronomy: E. C. Pickering, chairman.
VIII. Botany: J. M. Coulter, chairman.
IX. Zoology: E. G. Conklin, chairman.
X. Medicine and Hygiene: Victor C. Vaughan, chairman.
XI. Agriculture: Raymond Pearl, chairman.
XII. Physiology: W. B. Cannon, chairman.
XIII. Geography: W. M. Davis, chairman.
XIV. Geology: John M. Clarke, chairman.
XV. Anthropology: Wm. H. Holmes, chairman.
XVI. Aeronautics: Charles D. Walcott, chairman.
XVII. Nitrate supply: Arthur A. Noyes, chairman.

The offices of the council are at the Smithsonian Institution, and with the Engineering Foundation, Engineering Societies' Building, New York City.

GEORGE E. HALE, *Chairman.*

REPORT OF THE COMMITTEE ON PANAMA CANAL SLIDES.

Mr. Van Hise, chairman of the committee appointed at the request of the President of the United States to investigate the landslides which have interfered with the use of the Panama Canal, offered an informal forecast of the committee's report.

Moved:

That the printing of the final report be referred to the council with power.

Adopted.

MINUTES.

The home secretary was directed to send copies of the minutes of each business session of the academy to all members of the academy for approval and correction.

PROCEEDINGS.

Moved:

That papers by nonmembers appearing in the Proceedings be announced as "communicated by" some member.

Adopted.

J. LAWRENCE SMITH FUND.

The following recommendation of the chairman of the committee on the J. Lawrence Smith fund was adopted:

That a grant of $500 be made from the J. Lawrence Smith fund to Mr. George Perkins Merrill to further aid his studies of rare meteorites.

MARSH FUND.

The chairman of the committee on the Marsh fund made written recommendation:

That a grant of $400 be made from the Marsh fund to Mr. John M. Clarke for a study of mutualism, symbiosis, and dependent life among animals of geologic time.

Adopted.

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COMMITTEE ON THE MEDAL FOR EMINENCE IN THE APPLICATION OF SCIENCE TO THE PUBLIC WELFARE.

Mr. Becker, chairman of the committee on the medal for eminence in the application of science to the public welfare presented the following report:

The committee recommends that the public welfare medal be bestowed upon Dr. S. W. Stratton, for his services in introducing standards into the practice of technologists in the United States, at the stated session in April, 1917.

GEORGE F. BECKER.

NOVEMBER 6, 1916.

The recommendation was adopted.

BIOGRAPHICAL MEMOIRS.

A committee on the preparation of biographical memoirs was authorized and the following committee appointed: Mr. Davenport, chairman; Mr. Comstock, Mr. Mayer, the home secretary (ex officio).

The president announced the assignment of the biography of Mr. Cleveland Abbe to Mr. W. J. Humphreys, and that of Mr. Josiah Royce to Mr. John Dewey.

COMMITTEE ON SYNTHETIC ORGANIC CHEMISTRY.

Mr. Bogert reported as chairman, from the committee on synthetic organic chemistry, that the activities of the committee had now been merged with the National Research Council, and asked that the committee be discharged. The report was accepted and the committee discharged.

SCIENTIFIC SESSIONS.

MONDAY, NOVEMBER 13.

AFTERNOON SESSION.

Welcome by President MACLAURIN, of the Massachusetts Institute of Technology.

RAYMOND PEARL, Maine Agricultural Experiment Station. Some effects of the continued administration of alcohol to the domestic fowl, with special reference to the progeny. (20 minutes, lantern.)

EDWARD S. MORSE, Salem, Mass. Protoconch of Solemya. (10 minutes.)

ALFRED G. MAYER, Marine Laboratory, Carnegie Institution. Further studies of nerve conduction. (10 minutes, lantern.)

E. G. CONKLIN, Princeton University. The share of egg and sperm in heredity. (10 minutes, lantern.)

JACQUES LOEB, Rockefeller Institute. Diffusion and secretion. (12 minutes.)

LAFAYETTE B. MENDEL and S. E. JUDSON, Yale University. Some interrelations between diet, growth, and the chemical composition of the body. (12 minutes.)

ALESSANDRO FABBRI (introduced by A. G. MAYER). Micro-cinematographs of marine and fresh water organisms. (15 minutes, lantern.)

HENRY L. ABBOT, Cambridge, Mass. *Hydrology of the Isthmus of Panama.

JOHN M. CLARKE, State Museum, Albany. *The strand and the undertow.

* Papers marked with an asterisk were presented by title.

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W. LINDGREN, Massachusetts Institute of Technology. *Notes on the deposition of quartz, chalcedony, and opal.

W. M. DAVIS, Harvard University. *Sublacustrine glacial erosion in Montana.

EVENING SESSION.

President W. H. WELCH, Johns Hopkins University. The formation of the National Research Council at the request of the President of the United States. (15 minutes.)

Dr. S. W. STRATTON, Director of the National Bureau of Standards, Washington. Target practice in the Navy and some of the research problems involved; illustrated with moving pictures. (45 minutes.)

Reception and scientific exhibit in the general library from 9.15 to 10.30. (See list of exhibits below.)

TUESDAY, NOVEMBER 14.

MORNING SESSION.

EDWIN H. HALL, Harvard University. Electric conduction in metals. (20 minutes, lantern.)

EDWARD B. ROSA, National Bureau of Standards. The silver voltameter as an international standard. (15 minutes.)

R. W. WOOD, Johns Hopkins University. One-dimensional gases and the reflection of molecules. Series in resonance spectra. (10 minutes, lantern.)

ELIHU THOMSON, Swampscott, Mass. Inferences concerning auroras. (20 minutes.)

A. A. MICHELSON, University of Chicago. Report of progress in experiments for measuring the rigidity of the earth. (10 minutes.) The laws of elastico-viscous flow. (10 minutes.)

C. G. ABBOT, Smithsonian Institution. On the preservation of knowledge. (5 minutes.)

FRANZ BOAS, Columbia University. Further evidence regarding the instability of human types. (20 minutes.)

ROSS G. HARRISON, Yale University. Transplantation of limbs. (20 minutes, lantern.)

CHAS. B. DAVENPORT, station for experimental evolution, Carnegie Institution. Heredity of stature. (20 minutes, lantern.)

F. R. MOULTON, Chicago University. *On analytic functions of infinitely many variables.

HENRY S. WHITE, Vassar College, F. N. COLE and LOUISE D. CUMMINGS. *Enumeration of all triad systems on fifteen elements.

A. G. WEBSTER, Clark University. *Practical tests of a new phonotrope.

EDW. L. NICHOLS, Cornell University. *New data on the phosphorescence of certain sulphides.

G. P. BAXTER and H. W. STARKWEATHER, Harvard University. *A revision of the atomic weight of tin.

T. W. RICHARDS and H. S. DAVIS, Harvard University. *Improvements in calorimetric combustion.

T. W. RICHARDS and C. WADSWORTH 3d, Harvard University. *Further study of the atomic weight of lead of radioactive origin.

GILBERT N. LEWIS, University of California. *Chemical affinity.

WM. TRELEASE, University of Illinois. *The American oaks.

H. S. JENNINGS, Johns Hopkins University. *The numerical results of diverse systems of breeding, with relation to two pairs of factors, linked or independent.

* Papers marked with an asterisk were presented by title.

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W. R. MILES, Carnegie Nutrition Laboratory, Boston (introduced by F. L. Benedict). *Some psycho-physiological processes as effected by alcohol. (12 minutes.)

WALTER B. CANNON, Harvard University. *Oscillatory variations in the contraction of rhythmically stimulated muscles.

WM. H. DALL, Smithsonian Institution. *On some anomalies in the distribution of Pacific coast mollusks.

G. H. PARKER, Harvard University. *The responses of hydroids to gravity.

W. M. WHEELER, Harvard University. *The phylogenetic development of subapterous and apterous castes in the Formicidae.

W. J. CROZIER, Resident Naturalist, Bermuda Biological Station (introduced by E. L. Mark). *On cell penetration by acids: the chloracetic acids. *On the immunity coloration of some nudibranches.

HOVEY JORDAN, Bermuda Biological Station (introduced by E. L. Mark). *The rheotropism of the marine fish known as "hamlet" or "grouper" (*Epenephalus striatus*).

A. C. WALTON, Harvard University (introduced by E. L. Mark. *The occurrence of *Ascaris triquetra*, Schrank, in dogs.

AFTERNOON SESSION.

This session was devoted to a meeting of the National Research Council with the National Academy.

PROF. GEORGE E. HALE, Chairman of the National Research Council. The work of the National Research Council; Recent observations of organized science in England and France. (45 minutes.)

LIEUT. COL. GEORGE O. SQUIER, Chief of Aviation, United States Army. Scientific research for national defense, as illustrated by the problems of aviation. (20 minutes.)

PROF. ARTHUR A. NOYES, Massachusetts Institute of Technology. The nitrogen problem in war and in agriculture. (30 minutes.)

Discussion of the work of the National Research Council followed.

SCIENTIFIC EXHIBITS.

H. S. WHITE, Vassar College. Graphic representations of triad systems.

FRANK SCHLESINGER, Allegheny Observatory, Allegheny, Pa. Photographs of Jupiter.

Miss A. J. CANNON, Harvard College Observatory. Stellar spectra.

LEON CAMPBELL, Harvard College Observatory. Visual observations of variable stars.

Miss H. S. LEAVITT, Harvard College Observatory. Photographic magnitudes.

SOLON I. BAILEY, Harvard College Observatory. Variable stars in clusters.

A. G. WEBSTER, Clark University. Acoustical measuring apparatus: Standard phone, phonometer, and phonotrope. Application of a drop chronograph for use in ballistics.

CHARLES A. KRAUS, Clark University. A new vacuum pump and a new thermostat.

H. P. HOLLNAGEL, Massachusetts Institute of Technology. Methods of isolating the infra-red region of the spectrum.

ALEXANDER MCADIE, Blue Hill Observatory. Cloud studies, wind structure and snow flakes.

ELLSWORTH HUNTINGTON, Milton, Mass. The relation between solar changes and barometric gradients.

* Papers marked with an asterisk were presented by title.

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ROBERT DEC. WARD, Harvard University. Weather types of the United States, illustrated by composite weather maps and instrumental records.

R. A. DALY and H. CLARK, Harvard University. Design for a deep-sea thermograph.

FRANK HALL, Massachusetts Institute of Technology. A thermophone arranged so that direct comparison may be made with a magnetic receiver.

F. G. KEYES and J. B. DICKSON, Massachusetts Institute of Technology. Continuous flow calorimeter for measuring heats of reaction in solution.

S. P. MULLIKEN, Massachusetts Institute of Technology. A procedure for the identification of pure organic compounds.

C. K. REIMAN, Massachusetts Institute of Technology. Physico-chemical methods for purifying gases and the determination of their molecular weights.

R. E. WILSON, Massachusetts Institute of Technology. Apparatus for maintaining pressures of one-tenth micron or less, and the investigation of the mechanism of chemical reactions.

C. L. BURDICK, Massachusetts Institute of Technology. Determination of crystal structure by X rays.

HENRY FAY, Massachusetts Institute of Technology. Erosion of large guns.

ALBERT SAUVEUR, Massachusetts Institute of Technology and Harvard University: 1. Photomicrographic apparatus (original). 2. Photomicrographs of metals and alloys; charts and diagrams; specimens.

H. O. HOFMAN, Massachusetts Institute of Technology. 1. Jenny flotation machine. 2. A laboratory revolving horizontal roasting furnace heated electrically and rotated in the same way.

A. E. KENNELLY and Associates, Massachusetts Institute of Technology. Researches in electrical engineering.

ALEXANDER KLEMIN, Massachusetts Institute of Technology. Aeroplane models used in wind tunnel.

W. LINDGREN and W. L. WHITEHEAD. Massachusetts Institute of Technology. Photomicrographs of silver ores from Chile and Tintic.

CHARLES PALACHE, Harvard University. Models showing gnomonic crystal projection.

C. H. WARREN, Massachusetts Institute of Technology. 1. A graduated sphere for crystallographic work. 2. Photographs of spherulites in polarized light.

WALLACE W. ATWOOD, Harvard University. The former glaciers of the San Juan Mountains of Colorado. The physiographic stages in the evolution of the San Juan Mountains of Colorado.

J. B. WOODWORTH, Harvard University. Glacial map of Cape Cod and adjacent islands. A glypolith from Nantucket.

LAURENCE LA FORGE, United States Geological Survey. Recent topographic and geologic maps of New England and other parts of the United States.

W. M. DAVIS, Harvard University. New maps of Hawaii, indicating the subsidence of an active volcano.

H. W. SHIMER, Massachusetts Institute of Technology. Evolution of some brachiopods.

RICHARD M. FIELD, Harvard University. Ordovician rocks and faunas of central Pennsylvania.

W. B. SCOTT, Princeton University. Proofs of plates for forthcoming report on paleontology of Patagonia.

EDWARD S. MORSE, Salem. Southern mollusks in the till of Boston Bay.

W. J. V. OSTERHOUT, Harvard University. Pigments produced by the oxidation of a colorless plant chromogen.

CHARLES W. JOHNSON, Boston Society of Natural History. Distribution and variation of Helix hortensis.

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JOSEPH A. CUSHMAN, Boston Society of Natural History. Some fossil and recent foraminifera.

ALFRED G. MAYER, marine laboratory, Carnegie Institution. Yacht and laboratory of the Carnegie Institution at Torturas, Florida.

HUBERT LYMAN CLARK, museum of comparative zoology, Harvard University. Echinoderms from Torres Straits, Australia, with colored drawings and lithographs.

G. H. PARKER, Harvard University. The suction efficiency of a Californian sea anemone.

W. T. BOVIE, Harvard University. Visible effects of Schumann rays on protoplasm. Effects of radium rays on permeability of protoplasm.

W. M. WHEELER, Bussey Institution, Harvard University. Insects associated with ants and termites.

C. T. BRUES, Bussey Institution, Harvard University. Specimens and charts illustrating insects as carriers of infantile paralysis.

FREDERIC G. CARNOCHAN, Bussey Institution, Harvard University. Collections of beetles of the family Histeridae, with photographs of the anatomy.

W. E. CASTLE, Bussey Institution, Harvard University. Examples of Mendelian inheritance, reversion and variety formation in rats and guinea pigs.

FRANCIS G. BENEDICT, nutrition laboratory, Carnegie Institution. Respiration apparatus for animals.

T. B. OSBORNE, Connecticut Agricultural Experiment Station, and L. B. MENDEL, Sheffield scientific school, Yale University. Photographs representing the growth of chickens fed with definite mixtures of food stuffs under laboratory conditions which have heretofore not led to success.

I. CHANDLER WALKER, medical service, Peter Bent Brigham Hospital. Proteid sensitization in relation to bronchial asthma.

H. S. WELLS, medical service, Peter Bent Brigham Hospital. Electrocardiography, or the application of the string galvanometer to the study of cardiac cases.

ALBERT A. GHOREYEB, Cancer Commission, Harvard University. Metal casts of heart and kidney blood vessels.

S. B. WOLBACH, Harvard Medical School. Studies in Rocky mountain spotted fever.

HARVEY CUSHING and W. M. BOOTHBY, Peter Bent Brigham Hospital. Apparatus of routine methods for clinical metabolism determinations.

E. W. GOODPASTURE, Peter Bent Brigham Hospital. An anatomical study of senescence, with especial reference to tumors.

E. E. TYZZER and C. C. LITTLE, Harvard Medical School. The inheritance of susceptibility to transplanted tumor.

W. DUANE, Harvard Medical School. The technique of the preparation of radium for therapeutic purposes.

G. C. WHIPPLE, school for health officers, of Harvard University and Mass. Inst. Technology. Charts showing organization and membership of the school.

W. T. SEDGWICK, Massachusetts Institute of Technology. 1. Diagrams and tables illustrating the investigations of Professor Weston and Mr. Turner upon 'The digestion of sewage effluents in an otherwise unpolluted stream." 2. An investigation of the behavior of certain species of bacteria in various materials between zero Centigrade and zero Fahrenheit. 3. A field investigation of the sanitary environment of a suburban population.

S. C. PRESCOTT, Massachusetts Institute of Technology. Diseases of the banana in Central America, and their control.

ALFRED M. TOZZER, Peabody Museum, Harvard University. Race mixture in Hawaii.

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CHARLES PEABODY, Peabody Museum, Harvard University. Prehistoric specimens from caves of France and Palestine.

E. A. HOOTON, Peabody Museum, Harvard University. Casts and reconstruction of ancient man; skull of apes.

S. J. GUERNSEY, Peabody Museum, Harvard University. Cave explorations in northeastern Arizona.

ORIC BATES, Peabody Museum, Harvard University. Prehistoric Libyan remains.

HENRY DRAPER MEDALLISTS.

The Draper medal was awarded to W. W. Campbell, now director of the Lick Observatory, at the annual dinner of the National Academy of Sciences in 1906. A statement of this award was omitted from the annual report of that year and for that reason was not included in the semicentennial volume, entitled "The National Academy of Sciences, 1863–1913." The list of recipients of the Draper gold medal should read:

1886. Samuel Pierpont Langley: For researches and discoveries in relation to solar radiation.

1888. Edward Charles Pickering: For recent work in astronomical photometry and photography.

1890. Henry Augustus Rowland: For researches in the solar spectrum.

1893. Herman Karl Vogel: For spectroscopic observations upon the motion of stars in the line of sight.

1899. James Edward Keeler: For researches in spectroscopic astronomy.

1901. Sir William Huggins: For investigations in astronomical physics.

1904. George Ellery Hale: For investigations in astronomical physics.

1906. W. W. Campbell: For his observations and researches relating to the motions of stars in the line of sight, his improvements in the methods of measuring such motions, his discussions of conclusions to be drawn from them, and the organization of work in this field in the southern hemisphere.

1910. Charles Greeley Abbott: For researches on the infra-red region of the solar spectrum and his accurate measurements, by improved devices, of the solar "constant" of radiation.

1913. Henri Deslandres: For physical observations of solar eclipses; investigations of electric and magnetic phenomena of the sun; contributions to our theories of auroras, new stars, and nebulae; studies of spectra of the sun, stars, and comets, and photographic determinations of the rotation period of planets.

1915. Joel Stebbins: For his work on the application of the selenium cell to stellar photometry.

DECEASED MEMBERS.

ARTHUR WILLIAMS WRIGHT.

Prof. Arthur Williams Wright died at his home in New Haven, Conn., on December 19. He was born on September 8, 1836, in Lebanon, Conn., where his father, Jesse Wright, at one time a member of the Connecticut House of Representatives, served as justice of the peace, selectman, and a member of the school board. Samuel Wright, who settled in Springfield, Mass., in 1639, was his earliest paternal

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ancestor in this country. His mother was Harriet, daughter of William Williams and a descendent of Robert Williams, who came to this country from England in 1637, settling at Roxbury, Mass.

He received his early education in his native town, preparing for college, under William Kinne, at Canterbury. His career as an undergraduate at Yale College was a distinguished one. He not only achieved notable successes as a scholar in mathematics and astronomy, his studies of predilection, and in Latin, but he was prominent in undergraduate social life. A lifelong love for music naturally led him to identify himself with the musical organizations of his time, and a critical knowledge of music, including an enviable skill in performance, added largely to the pleasures of his later and more leisurely life.

After graduation he continued his studies at Yale, specializing in mathematics and science, and acquired the degree of Ph. D. in 1861. From this time until his retirement in 1906 his life was identified with Yale, except for a period in 1868–69, when he studied at Heidelberg and at Berlin, and the three years 1869–1871, during which he held a professorship of physics and chemistry at Williams College. In the last-named year he returned to Yale as professor of molecular physics and chemistry.

One of Prof. Wright's most distinguished services to his university, and indeed to the teaching of science in America, was the early recognition that the practice of combining professorships of physics and of chemistry had ceased to be either economical or possible. It was, therefore, under his stimulus and activity that the first Sloane Laboratory of Yale College, the first structure in the country devoted exclusively to the work of a physical laboratory in the modern sense—was designed and constructed. This was completed in 1883, and henceforth he devoted his time, until his final retirement, to instruction and various physical investigations there, although the title of his professorship was not changed to that of molecular physics until 1887. This Sloane Laboratory also contained the study and lecture room of Prof. J. Willard Gibbs, whose contributions to physical sciences have made it celebrated for all time.

The greater portion of Prof. Wright's scientific work found its first publication in the "American Journal of Science." These contributions are not merely important, they are characterized by rare excellence of form and of clarity.

In Volumes IX to XII we find a series of papers, five in all, of great interest, on the gaseous contents of meteoric irons and stones. In the first of these papers he reviews the known results of the investigations upon the occluded gases of meteoric irons, quoting Prof. Graham and Prof. J. W. Mallett. In his own investigations the material came for the most part from the collection in the possession of Yale

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University. His conclusions in this first paper were that no one of the several irons which he studied gave any spectroscopic evidences of unknown elements.

In volume X, "Examination of gases from the meteorite of February 12, 1875," Prof. Wright gives a thorough review of the gaseous contents of this meteor. It appears to be the first stony meteor thus investigated and the results are of great importance; they not only show the presence of gases occluded in stony meteors but that they are distinguished by having oxides of carbon as their characteristic gases, instead of hydrogen. He points out the bearing of these observations upon the peculiar spectra of comets and as a support of the meteoric theory of comets.

In volumes XI and XII Prof. Wright continued these important investigations, extending them to a considerable number of stony meteors of known origin. The earlier conclusion that stony meteors are characterized by a large amount of occluded carbon compounds was abundantly verified, and the last paper contains a long discussion concerning the bearing of these observations on the current theory of comets.

In 1877 Prof. Wright published two important papers, in volumes XIII and XIV, respectively, on the deposition of metallic films by the cathode discharge in exhausted tubes. A clear description of the technique of the process and of the physical properties of a large number of metals thus treated makes the papers of unusual interest. The intrinsic value of his method has proved so great that it is quite probable that the name of the author is more widely known from these scientific contributions than from any others published during his long and active life.

Prof. Wright was a fellow of the Royal Astronomical Society of Great Britain and of the American Association for the Advancement of Science; he was a member of the American Physical Society. of the National Academy of Sciences, and of other learned societies.

C. S. HASTINGS.

(Extract from Science, n. s. Vol. XLIII, No. 1104, Feb. 25, 1916, p. 270.)

JOSIAH ROYCE.

In the sixth book of "The Republic," Plato paints the portrait of the ideal or, as he says, "the true" philosopher. He must be a man of quick mind and retentive memory, devoted to truth and abhoring falsehood in every shape, temperate, and thoroughly uncovetous, with no taint of meanness or little-mindedness or cowardice, gentle and just in his dealings with men; one whose spirit is full of lofty thoughts and privileged to contemplate all time and all existence, and who is, therefore, fearless in the face of death; one who is enamoured of all learning that will reveal somewhat of that real and

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permanent existence which is exempt from the vicissitudes of generation and decay, and of the whole of that real existence, willingly resigning no part of it, great or small, honored or dishonored.

A rare combination! And the fortunate possessor of these gifts now, as in ancient Athens, is almost irresistably enticed away into less exalted pursuits.

Plato goes on to describe how puny souls, seeing the fair field of philosophy all but deserted, rush in to take possession, likening them to some baldheaded little tinker who has suddenly amassed a fortune, and taking advantage of his master's poverty, married his daughter. What can one expect in such a case but a base-born progeny! What in the former case but a spurious brood of sophistries! Whether this description fits our day, let the reader decide. Certain it is that the virtues Plato enumerates as essential to full capacity for philosophy were in Josiah Royce singularly combined, and that from his youth up he was steadfastly and unreservedly devoted to the cause of truth.

I am impressed by the massiveness of his learning. His mind was fashioned on cosmic proportions. I do not mean by this merely that his interest centered in la haute metaphysique, and that he fearlessly faced the problems, old as reflective thought itself, concerning God and nature and man, interpreting them in the light of recent scientific discoveries, and giving us new readings of ancient issues. Nor do I refer to the wide range of his intellectual interests, although as a polymath he ranks with the greater philosophers of the past, making contributions to mathematics and logic as well as to all the more strictly philosophical disciplines, and being familiar to an unusual degree with the work of recent science in its various fields.

On one occasion at a club some one who had made a special study of the subject read a paper on meteorology, a theme that might seem remote enough from philosophical interests. Royce discussed it, and, such was his evident mastery of the subject, for the rest of the evening questions were addressed to him rather than to the reader of the paper. The instance is typical. He was always surprising one with such glimpses of hidden lore.

But what I have in mind is rather this: Royce never lost sight of the fact that philosophy's ambitious aim is vision in the light of the whole. And he always lived with his vision. This gave him not only his unusual serenity and poise, but also a facility (sometimes an almost suspicious facility) in piecing together the fragments of knowledge like the fragments of a puzzle picture until the pattern of the whole was revealed. And all the little and seemingly trivial incidents of life were, for him, fraught with universal significance.

Once on a street car in New York he had occasion to take a transfer. But he never put it to its intended use. It was too precious

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for that. For on the back was an advertisement in which these sentences appeared:

> Individuality sets you apart from all other persons who might possibly be just like you. The average woman feels that she might as well be dead as to be out of fashion. She wants to wear what everybody else wears, but it must be with a difference.

And this transfer slip becomes the text of a lecture on dialectic, on identity and difference, and the principle of individuation. I may be pardoned for mentioning these incidents, for they illuminate the character of the man. There was something essentially Socratic in this habit of elevating the commonplace and in this combination of the serious and the playful.

James once remarked that the average undergraduate rarely understood Royce, but that he always had a sense that something big was going on. He was not, indeed, a successful teacher of undergraduates. This is, however, less a reflection on Royce than on the undergraduate, who has been pretty generally spoiled and expects to have truth handed to him diluted and peptonized. Royce never insulted the intelligence of his students by offering them a consistent and tenable theory of the universe wrapped in neat word packages. But in dealing with the graduate students he was masterful, always encouraging their independent efforts, giving them confidence in themselves and in the power of reason, yet always ready to put to rout the overconfident zealot by piercing his pet dogmas with a few skillful questions. He always showed a rare intellectual detachment. He was never the partisan of his own convictions; never sought to make proselytes. Never was an absolutist less concerned with having followers. Philosophy as he viewed it was always an individual venture, and he knew that only the least original of students ever repeat a teacher's views, and that one's most helpful collaborators are often one's severest critics.

But, above all, at this time, one must think of Royce as preeminently a good man, gentle and kindly, generous and unworldly, whose life was the embodiment of the philosophy of loyalty that he taught. In the face of the greatest personal affliction that can befall a man, his courage was undaunted, his head "bloody but unbowed." A few years ago, suffering an attack which would have led most men to surrender, he was but stimulated to greater effort, and put forth some of his best work, as if his intellect burned on with increasing brilliancy as his frail body wasted away; until, finally, the machinery stopped, and he fell asleep as peacefully as a tired child. We bow our heads and are fain to repeat the words a loving disciple uttered on the death of another great teacher of philosophy: "So perished the wisest and best man I have ever known."

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At its last annual meeting the American Philosophical Association, in memory of his sixtieth birthday, did Prof. Royce the signal honor of devoting two of its sessions to papers dealing with various phases of his work as a philosopher. These papers, with some others, have since been published as a commemorative volume by the Philosophical Review. This makes at once more difficult and less necessary the attempt to give here a critical estimate of his contributions to philosophy in its more technical aspects. I shall therefore confine myself to more general considerations.

The three names that stand out in the history of American speculative thought, preeminent above all others, are Jonathan Edwards, William James, and Josiah Royce. What Edwards accomplished in interpreting the spirit of American life and ideals in his day, James and Royce have accomplished in interpreting the spirit of American life and ideals in our own day.

It is customary to represent James and Royce as totally opposed in their philosophies, the one an empiricist and pragmatist, the other a rationalist and absolute idealist. I have no desire to minimize the differences between them—and they were frequently engaged in polemical controversy. But on the great thinkers all labels are misfits. And with them agreements are generally more numerous and more fundamental than differences. In this case I think the philosophies are complementary rather than antagonistic. It is certain that Prof. Royce regarded himself as a disciple of Prof. James, however unruly a one he may have been, and always generously acknowledged his indebtedness to him. And James was no less generous in the expression of his admiration for his younger colleague.

It is significant that both men received their early inspiration from men of science—the one from Agassiz, the other from Agassiz's brilliant pupil, Joseph Le Conte. Both were caught by the theory of evolution, were its enthusiastic exponents, and were bent on interpreting the larger problems of human life in its light. It is, however, no less significant that in their earliest scholarly activity James turned to anatomy, physiology, and psychology; Royce to literature, history, and logic. For as these differences suggest, James was from the first more interested in details, Royce in the completed vision.

This difference, which determines the divergence of their paths, is not unconnected with their personal history. James, brought up in the very center of New England culture, a social favorite from the start, breathing an atmosphere of absolutism and rationalism, is stifled by his surroundings, and, in search of air, freedom, elasticity, makes his escape to science and psychology. The bogeys in the background of his thinking are ever after verbalism, closed systems, and drab respectability. Royce, on the other hand, was born and

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spent his early years in a small mining town in California, at a time when frontier lawlessness and the days of the Vigilantes were still fresh in memory. The young Royce was uncouth, and awkward, and of very unusual appearance, with a slight body and a very large head (mostly forehead), crowned with a shock of bright red hair. Boys are cruel to a fellow of such strikingly unconventional appearance, and as Royce has said, although his classmates early taught him the "majesty of the community," he found the experience grievous rather than joyous. A certain shyness resulted, and both at school in San Francisco and later at the University of California he was essentially the solitary student, given much to reflection, but knowing little or nothing of the social and sportive sides of college life. The bogeys in the background of his thinking are ever after lawlessness, capriciousness, fragmentariness, and isolation; and he seeks refuge in those humane pursuits which ever aspire to a certain comprehensiveness of vision—literature and history and philosophy. But he is saved from vagueness and sentimentalism by the stiffening effect of logic. It was characteristic that when, after studying at Johns Hopkins and in Germany, he returned to his alma mater to take a position in English literature, he should have decided that his students needed discipline in logic, and that, finding no book on logic suited to his needs, he wrote one. For as James is always the psychologist, gifted with unusual powers of observation and description, so Royce is always the logician, as skillful in its art as he is master of its theory.

Both men were fearless and intrepid thinkers, singularly free from cant, and distrustful of all formulas, knowing well that when thought has crystallized in the phrase, the life of thought has departed. Both sought merely to interpret the facts of experience as they themselves had found them. Both, however, saw clearly that facts are not such simple things as the average fact-monger supposes; but that part at least of their meaning comes through the cooperation of the experiencer. And hence for both the ethical and religious interests are never long out of sight. Royce's first philosophical book is "The religious aspect of philosophy," and almost his last, "The problem of Christianity." Most of the essays in James's "Will to believe" were written early in his career, and the "Varieties of religious experience" comes toward its close.

In the all too simple classification of the day, James is set down as an empiricist, Royce as a rationalist; which distinction is explained by saying that the former looks to last things, facts, consequences, while the latter looks to first things, causes, principles. This is true enough as far as it goes. But it must be remembered that for James facts always include those larger human experiences which defy description in terms of the visible and tangible; and surely he was as

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far removed as Royce himself from the position of the pseudo-scientific philosopher, our modern positivist, who is in truth the representative in our day of the spirit of medievalism, with its fondness for verbal solutions and its tendency to hypostasize abstractions. And for Royce principles are not decrees fulminated from eternity, in advance of facts, but are rather the threads of meaning that run through the facts of experience and bind them together.

Again, Royce is called a monist, James a pluralist. In his earliest work Royce does indeed find the desired unity in the concept of the Absolute or Logos, in whose life our partial purposes and fragmentary meanings are harmonized. The monistic tendency of this work was early the object of attack, the most notable assault being that of Prof. Howison, against which Prof. Royce sought to defend his doctrine in the supplementary essay published in "The concept of God." And I think it is clear that a large part of Prof. Royce's work throughout the remainder of his career is determined by this controversy and by similar attacks coming from other quarters, especially from his friend and colleague, James. His chief concern is to find in the world of the Absolute, elbow-room for the individual. And when, in his latest work, what he called "The Spirit of the beloved community" has taken the place of the Absolute of the earlier works, the term monism is hardly pertinent any longer. James, on the other hand, found forthwith the desired variety in the facts of experience. But I think it not an exaggeration to say that he spent his life in seeking to recover the lost unity through the discovery and justification of the faiths by which men actually live—which is what alone can save pragmatism from being merely a subtler form of opportunism.

Together, these two men stand as our great national philosophers, helping to define and make articulate the spiritual aspiration that underlies our experiment in democracy and justifies our confidence in its ultimate triumph, the one approaching his task mainly from the side of logic, the other mainly from the side of psychology.

We have, or flatter ourselves that we have, at last broken away from authority and tradition and dogma; we call ourselves progressives, are lovers of the concrete, believe in efficiency and the strenuous life, and admire, above all things, the man who "makes good." But while in its blatant spokesmen this Americanism smacks overmuch of the market-place and the athletic field, it is saved from such debasement by that deeper current of ethical idealism to which these thinkers have so clearly given voice.

CHARLES M. BAKEWELL.

(Extract from the Nation, Nov. 16, 1916, p. 461.)

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EUGENE WOLDEMAR HILGARD.

Eugene Woldemar Hilgard was born January 5, 1833, at Zweibruecken, in Rhenish Bavaria, the son of Theodore Erasmus and Margarethe Hilgard, and was the youngest of a family of four sons and five daughters. His father was a lawyer, holding the position of chief justice of the court of appeals of the province. Judge Hilgard having been born and educated under the shadow of the French Revolution and being of pronounced liberal views, stoutly opposed the supersedence of the Code Napoleon by the illiberal laws of the old régime. In 1838, when at the fullness of a successful career, he determined to emigrate to America with his family and settled on a farm at Belleville, Ill. As the public schools of that day were quite primitive Judge Hilgard personally undertook the preparation of his sons for entrance to the universities. Eugene was in readiness in 1849 and in that year returned to Germany to attend the University of Heidelberg, graduating with honors and a doctor's degree with summa cum laude in 1853. This degree was reissued to him in 1903 as a "golden degree" in recognition of half a century's good work for science. Returning to America, he began geological exploration work in Mississippi in 1855 and was appointed State mineralogist of that State in 1858. In 1866 he was chosen professor of chemistry in the University of Mississippi and later professor of geology, zoology, and botany. In 1872 he left Mississippi to take a position on the faculty of the University of Michigan, but remained there only two years, when he was called by the regents of the University of California to California in 1874. While developing agricultural instruction in the university, he proceeded with research work immediately after his arrival in California and published his first results in 1877. His work in the investigation of soils in connection with their native vegetation, of the influence of climate on the formation of soils, and especially of the nature of "alkali soils" and their reclamation, a problem quite new not only in this country, but in other arid regions, achieved for him a reputation as wide as the world of science. It brought him recognition on numerous occasions. Mississippi, Columbia, and Michigan Universities, as well as the University of California, have bestowed the doctor of laws degree upon him. The Academy of Sciences of Munich presented him with the Liebig medal for distinguished achievements in the agricultural sciences, and the international exposition at Paris, in 1900, gave him a gold medal as a collaborator in the same research.

Soon after coming to California he directed the agricultural division of the northern transcontinental survey. From 1879 to 1883, in connection with his university work, he assumed charge of the cotton investigation of the census of 1880 which he projected and

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carried out on a broader plan than ever before undertaken. During the whole period of his academic career Prof. Hilgard was constantly active in authorship. In addition to formal reports and memoirs, he wrote much for agricultural and scientific periodicals. His greatest book is Soils of Arid and Humid Regions.

The greater part of Hilgard's career was spent at the University of California. Of the many and various problems which he faced at the beginning of his work there, three seem at this moment to give best clue to the masterfulness of the man and fullest understanding of the breadth and depth of his success:

First. The conciliation and conquest of his farming constituency by demonstration of practical and indispensable value in the work he could do.

Second. The enforcement of recognition of agricultural studies as entitled to the dignity of higher learning and as possessed of pedagogic value.

Third. The securing of funds to pursue research which could alone yield truth about natural conditions affecting California farming, and to increase his working force, without which he could neither get the truth nor teach it in its several branches and applications.

Hilgard's work was permanently successful, because with clear vision he founded it upon principles the soundness of which has since been demonstrated and generally recognized. In his first report, published in 1877, he said:

> A knowledge of facts and principles and not the achievement of manual dexterity must be the leading object of a truly useful course of instruction in agriculture. * * * Object teaching should be made the preeminent method of instruction in natural and, more especially, in technical science. Manual exercise should be made the adjunct of the instruction in principles.

The stand taken by Hilgard with reference to the dignity and pedagogical value of agricultural science while so many institutions now great were in their formative periods was recognized as sound throughout this country and beyond. Set forth in his early reports, it exercised a profound influence. The proper relation of agricultural practice to agricultural science as factors in educational effort; the educational distinction between labor performed for enlightenment and labor prescribed to beget a liking for labor; the place of both the art and science of agriculture in a university of higher learning when both are handled ably for instructional purpose—these were among his fundamental contentions, upholding them through many controversies, and his victory is seen in their entry into the regular curricula of all of the newer institutions of learning and their pursuit by older institutions established upon other standards of learning before the existence of these educational factors was dreamed of as worthy and capable.

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Hilgard's strategic diversion of 1879 and 1883 was one of the brightest and most effective movements of his career. On the basis of his work in Mississippi he was requested by the Director of the Census of 1880 to take full charge of the cotton investigations for that census and to do something greater for the cotton industry than was ever done before, and he was promised funds for inquiry, investigation, laboratory work, and whatever else he deemed necesary to get at the fundamental facts and principles connected with cotton growing in the United States. He reviewed the subject as a whole and in divisions, studied each cotton State, and finally, after four years of work, produced in two volumes his report upon the cotton industry of the United States, a lasting benefit to all cotton-producing States. This report, in two quarto volumes, was a force in engrafting original research upon the instructional work established through the educational land-grant law of Morrill, by the enactment of the Hatch law for State experiment stations in all States.

The results of Hilgard's labors are in the warp of California's first half century of intellectual and industrial life. He was quick to see his opportunities for public service, to recognize his duty therein, and he was masterful and tireless in pursuit of it. He was bold in conquest of truth and fearless in his use of it for the interest of mankind, seizing gladly the smallest fact from research and pressing it to the humblest service, but always perceiving and enforcing the relations of both the fact and the service to the broadest interests of his States and of his fellow men.

E. J. WICKSON.

(Extract from Science, n. s., Vol. XLIII, No. 1109, p. 447.)

CLEVELAND ABBE.

The death of Cleveland Abbe near Washington, D. C., on October 28, in the seventy-eighth year of his age makes a gap of a special character in the ranks of meteorologists, and particularly among those who use the English language. From 1871 until August last, when he retired, Abbe was professor of meteorology in the United States Weather Bureau. That is the title which the bureau gives to the professional meteorologists on its staff. Born and educated in New York, he had been a teacher of mathematics in New York and of engineering at the State University, Ann Arbor, Mich. From there he went to Harvard University, 1860–1864, being at the same time aid in the United States Coast Survey under B. A. Gould; thence to the Central Observatory of the Russian Meteorological Service at Petrograd for two years; aid in the United States Naval Observatory, 1867–68, and director of the Cincinnati Observatory, 1868–1873.

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The work at the Weather Bureau for which he is best known is the editing of the Monthly Weather Review, which was in his charge from 1893 until his retirement, with a break of a few years from 1909, during which the Bulletin of Mount Weather Observatory took its place. Besides original papers, it includes the best monthly epitome of progress in meteorology in English, and ranks for that purpose with the Meteorologische Zeitschrift. This work gave Abbe an unrivalled knowledge of meteorological literature. He was a sort of college-tutor for the Weather Bureau, and with his encyclopaedic knowledge he was to a large extent the force behind the organization. He was a very keen advocate of the study of dynamical meteorology. Every student of the subject knows his collections of translations into English of classical papers in French and German which are published by the Smithsonian Institution. He founded a meteorological library at Johns Hopkins University and was professor of meteorology in the George Washington University of Washington. He was specially the promotor of meteorology. We owe to his instigation the installation by the Meteorological Office of the station now in operation at St. Helena. He wrote a large volume on the Maryland Weather Service, with a discourse upon aims and methods. That represents his interest. In an article in the "Encyclopaedia Britannica" it is the observation of clouds at sea that claims attention. He took part in a number of scientific expeditions for eclipses and other purposes, and he started the reform in civil time, reckoning by even hours from the Greenwich meridian, a reform which in Europe has over-shot itself into "summer-time."

Abbe's services to meteorology were recognized by the Royal Meteorological Society by the award of the Symons medal in 1912. He was a man of most genial disposition. His wife, the daughter of W. G. H. Percival, of St. Kitts, whom he married in 1909, survives him. One of the sons of his first marriage, Cleveland Abbe, junior, succeeds him as editor at the Weather Bureau.

NAPIER SHAW.

(Extract from Nature, vol. 98, No. 2461, Dec. 28, 1916, p. 332.)

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ANNUAL REPORT OF THE TREASURER.

JANUARY 1 TO DECEMBER 31, 1916.

To the PRESIDENT OF THE NATIONAL ACADEMY OF SCIENCES:

I have the honor to submit the following report as treasurer for the fiscal year, January 1 to December 31, 1916. Before presenting the detailed statements of the report some special features of the financial transactions of the year will be mentioned.

The income of the academy during the year from dues, investments, subscriptions to Proceedings, contributions to the Proceedings fund, and William Ellery Hale lectureship was $16,753.45. The miscellaneous expenditures, exclusive of investments, amounted to $8,536.43. Payments made on grants from various funds in aid of research and for medals amounted to $9,389.07.

The sum of investments held by the academy on December 31 was $228,001, yielding on that date at the rate of 4.99 per cent. The total income from investments received during the year was $11,814.94.

Changes in investments may be summarized as follows: One series of first mortgage notes on real estate amounting to $10,000 was paid in full, one was curtailed by the payment of $5,000 and three bonds of $1,000 each were called, and $3,020 paid for them. Bonds were purchased to the amount of $18,713.75.

The academy received during the year the sum of $6,921.84 from the estate of the late O. C. Marsh as deferred interest from March 18, 1900.

The special fund contributed by the members and friends of the academy toward the expenses of the publication of the Proceedings amounted to $2,178.33.

On February 1 the consolidated investment fund was established, as provided by the constitution and a resolution of the council. It embraces the capital of the Agassiz, Bache, Building, Draper, Elliot, Gibbs, Hartley, Marsh, and Smith funds, aggregating $159,827.18.

TRUST FUNDS OF THE ACADEMY.

The trust funds of the academy, the income of which is administered for specific purposes, are enumerated below. The capital of certain funds has been increased beyond the amount of the original gift or bequest, by the transfer of accumulated income, at the request of the donors or by action of the academy.

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Bache fund: Bequest of Alexander Dallas Bache, a member of the academy, 1870. To aid researches in physical and natural sciences $56,000.00

Watson fund: Bequest of James C. Watson, a member of the academy, 1874. For the promotion of astronomical science through the award of the Watson gold medal and grants of money in aid of research 25,000.00

Draper fund: Gift of Mrs. Henry Draper, 1883, in memory of her husband, a former member of the academy. To found the Henry Draper gold medal, to be awarded for notable investigations in astronomical physics. The balance of income is applied to aid research in the same science 10,000.00

Smith fund: Gift of Mrs. J. Lawrence Smith, 1884, in memory of her husband, a former member of the academy. To found the J. Lawrence Smith gold medal, to be awarded for important investigations of meteoric bodies and to assist, by grants of money, researches concerning such objects 10,000.00

Gibbs fund: Established by a gift of Wolcott Gibbs, a member of the academy, 1892, and increased by a bequest of the late Morris Loeb, 1914. For the promotion of researches in chemistry 5,545.50

Gould fund: Gift of Miss Alice Bache Gould, 1897, in memory of her father, a former member of the academy. For the promotion of researches in astronomy 20,000.00

Comstock fund: Gift of Gen. Cyrus B. Comstock, a member of the academy, 1907. To promote researches in electricity, magnetism, or radiant energy, through the Comstock prize, of money, to be awarded once in five years for notable investigations. The fund is to be increased ultimately to $15,000 ..... 11,337.50

Marsh fund: Bequest of Othniel Charles Marsh, a member of the academy, 1909. To promote original research in the natural sciences 10,127.65

Murray fund: A gift from Sir John Murray, 1911, to found the Alexander Agassiz gold medal, in honor of a former member and president of the academy, to be awarded for original contributions to the science of oceanography 6,000.00

Hartley fund: A gift from Mrs. Helen Hartley Jenkins, 1913-14, in memory of her father, Marcellus Hartley, to found the medal of the academy awarded for eminence in the application of science to the public welfare 1,200.00

In addition to the above-named trust funds the academy holds the following:

Agassiz fund: Bequest of Alexander Agassiz, a member of the academy, 1910, for the general uses of the academy $50,000.00

Building fund: A gift from Alexander Agassiz and Theodore N. Gill, former members of the academy, toward a building for the academy, together with accumulated income to Dec. 31, 1916 ..... 8,954.03

STATEMENTS OF ASSETS AND LIABILITIES, DECEMBER 31, 1916.

ASSETS.

1. Mortgage notes, secured by first mortgages on real estate $90,750.00
2. Bonds, giving name, face value, rate of interest, and cost:
   - 4 Asheville Power & Light Co. first mortgage, 30-year gold, 5 per cent, due Apr. 1, 1942. New York. Nos. 490, 492, 508, 509 ..... $3,920.00

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2. Bonds, etc.—Continued.

12 Broadway Realty Co. first, 5 per cent gold, due Sept. 1, 1926. Purchase money. 12 at $1,000. Nos. 38, 50, 796, 963–5, 1068, 1616–20	$12,345.00
10 Bush Terminal Building Co. first-mortgage 50-year sinking fund, 5 per cent gold bonds, due Apr. 1, 1860. 10 at $1,000. Nos. 1383–7 and 2805–9	9,375.00
5 Chesapeake & Ohio general mortgage 4.5's, gold bonds, due Mar. 1, 1992. 5 at $1,000. Nos. 15350, 15351, 15352, 15353, 15354	4,600.00
4 City of Tacoma Green River special water fund No. 2, 5 per cent, due Oct. 1, 1939. 4 at $1,000. Nos. 1508, 1809, 1510, 1511	4,140.00
7 Cleveland Electric & Illuminating Co. first-mortgage 5 per cent gold bonds, due Apr. 1, 1939. 4 at $500 and 3 at $1,000 each. Nos. M6060, M6096, M6097, D261, D262, D263, D264	5,097.50
19 Cosmos Club 4.5 per cent bonds, due July 1, 1949. 29 at $1,000. Nos. 286–297, 299, 301–305, 350	19,000.00
7 Detroit Edison Co. 5's, first mortgage, 30-year gold, due Jan. 1, 1933. 7 at $1,000. Nos. 557, 2442, 2443, 3024, 3252, 3253, 3086	7,177.50
5 Dominion Coal Co. (Ltd.) first-mortgage sinking-fund gold bonds, 5 per cent, due May 1, 1940. 5 at $1,000. Nos. A1036–A1040	4,675.00
2 Georgia Railway & Electric Co. first consolidated mortgage 5's, sinking fund, gold, due Jan. 1, 1932. 2 at $1.000. Nos. 1061, 1600	2,055.00
13 Government of the Province of Alberta bonds, 4.5 per cent, 10-year gold debenture, due Dec. 1, 1923. 2 at $500 and 11 at $100. Nos. 2031 and 2032, 1501–1511	2,008.50
6 Government of the Province of Alberta bonds, 5 per cent, 10-year gold debenture, due May 1, 1925. 1 at $1,000 and 5 at $500. Nos. 2364, B189–B195	3,373.75
1 Government of the Province of Alberta bond, 4.5 per cent, 10-year gold debenture, due Feb. 1, 1924. 1 at $500. No. 2620	480.00
4 Grand Rapids Gas Light Co., 5 per cent, first mortgage gold, due New York, August 1, 1939. 4 at $1,000. Nos. A522, A523, A595, A596	4,020.00
9 Milwaukee Railway & Electric Light Co. general and refunding mortgage gold bond, series A, 5 per cent, due Dec. 1. 1951. 6 at $1,000. Nos. 2772, 5222, 5223, 5224. 3839, 3840, 3930, 3931, 2088	8,237.50
6 Minneapolis General Electric Co. 5 per cent 30-year gold mortgage bonds, due Dec. 1, 1934. 6 at $1,000. Nos. 1621, 1622, 1949, 2004, 7579, 7580	6,100.00

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2. Bonds, etc.—Continued.		
4 Niagara Falls Power Co. first mortgage, 5's, gold coupon bonds, due Jan. 1, 1932. 4 at $1,000. Nos. 5246, 5247, 6583, 8358	$4,100.00	
18 Riggs Realty Co. 3/30-year coupon bond, first, 5's, due Oct. 1, 1940. 18 at $1,000. Nos. 76, 80, etc., to 144	18,572.50	
9 Southern Bell Telephone & Telegraph Co. 30-year, first mortgage, 5's, sinking fund, gold bonds. Due Jan. 1, 1941. 9 at $1,000. Nos. M9739, M11576, M11577, M11578, M11579, M13965, M15568, M15569, M15570	8,942.50	
1 Union Electric Light & Power Co. of St. Louis, first, 5's, due Sept. 1, 1932. 1 at $1,000. No. 4169	1,010.00	
5 Vicksburg, Shreveport and Pacific Railroad Co. Prior lien mortgage, at 6 per cent, gold bond, due Nov. 1, 1915, extended at 5 per cent to Nov. 1, 1940. Nos. 561, 661, 794, 982, 1323	5,050.00	
8 Virginian Railway Co., 1st mortgage, 50-year gold bond, series A, at 5 per cent, due New York, May 1, 1962. Nos. M4290, M4291, M14151	2,971.25	
		$138,015.60
3. Bank balance, Dec. 31, 1916[1]		29,551.64
		257,552.64

LIABILITIES.

	Income.	Capital.
General fund:		
Invested	$4,686.25	
Uninvested	1,006.96	
Agassiz fund:		
Invested[2]		$50,000.00
Uninvested		
Bache fund:		
Invested[2]	2,575.00	56,000.00
Uninvested	909.35	
Building fund:		
Invested[2]		8,954.03
Uninvested		
Comstock fund:		
Invested	677.50	11,315.00
Uninvested	1,297.32	22.50
Consolidated fund:		
Invested		
Uninvested	1,742.30	
Draper fund:		
Invested[2]	1,952.50	10,000.00
Uninvested	245.19	
Elliot fund:		
Invested[2]		8,000.00
Uninvested	114.98	

[1] Three outstanding checks, $82.25.

[2] Full amount of capital invested as part of the consolidated fund.

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Gibbs fund:		
Invested [1]		$5,545.56
Uninvested	$272.25	
Gould fund:		
Invested	4,067.50	17,963.75
Uninvested	929.06	2,036.25
Hale lectureship:		
Invested		
Uninvested	1,000.00	
Hartley fund:		
Invested [1]		1,200.00
Uninvested	108.98	
Marsh fund:		
Invested [1]	677.50	10,127.65
Uninvested	8,031.95	
Murray fund:		
Invested		5,965.00
Uninvested	274.97	35.00
National research council:		
Invested		
Uninvested	50.00	
Proceedings:		
Invested		
Uninvested	1,218.37	
Smith fund:		
Invested [1]	1,532.50	10,000.00
Uninvested	841.38	
Watson fund:		
Invested		24,922.50
Uninvested	1,176.15	77.50
	35,387.96	222,164.68
		35,387.96
		257,552.64
Consolidated fund:		
Invested		151,666.00
Uninvested		8,161.18

CONDENSED STATEMENT OF RECEIPTS AND EXPENDITURES, 1916.

RECEIPTS.

Balance Jan. 1, 1916, as per last report	$15,147.15
Total income from investments	11,814.94
Bond transfer	2,040.00
Mortgage notes paid	15,000.00
Bonds called in	3,020.00
Annual dues:	
1914	
1915	
1916	735.00

[1] Full amount of capital invested as part of the consolidated fund.

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Interest on bank deposits	$251.31
William Ellery Hale lectureship	1,000.00
Contributions to Proceedings	2,178.33
Subscriptions to Proceedings	773.87
Reprints and separate numbers of Proceedings	525.15
Return of grant by A. H. Pfund to Gould fund	501.78
Deferred interest from Marsh estate	6,921.84
Return from Murray fund to general fund	.03
Return from Elliot fund to general fund	73.06
Transfers on account consolidated fund	3,394.81
Transfer Bache to Marsh fund (rectifying error)	472.50
Gift from Margaret Henderson Elliot	8,000.00
Gift to National Research Council	50.00
Receipt of income from consolidated fund	3,923.82
	75,823.59

EXPENDITURES.

Investment of capital		$16,800.00
Investment of income		1,913.75
Transfer of investments		2,040.00
Distribution income consolidated fund		3,923.82
Transfer income to capital		1,255.98
Transfer various funds to consolidated		2,136.18
Accrued interest		200.98
Payments from trust and other funds:		
Bache fund—		
J. P. Iddings	$1,000.00	
C. A. Kofoid	500.00	
R. A. Daly	1,000.00	
J. Voûte	401.00	
R. W. Hegner	160.00	
G. P. Baxter	300.00	
Louis T. Moore	500.00	
R. R. Reagan	100.00	
H. W. Norris	100.00	
A. F. Shull	100.00	
W. C. Allee	415.00	
Draper fund—		
Joel Stebbins	300.00	
Philip Fox	250.00	
Gibbs fund—		
G. P. Baxter	300.00	
Gould fund—		
Astronomical Journal	1,000.00	
E. B. Frost	40.00	
E. B. Frost	600.00	
Hale lectureship honorarium—		
H. F. Osborn	300.00	
Hartley medal—		
Cleveland Abbe, Gifford Pinchot	42.57	
Smith fund—		
S. A. Mitchell	300.00	

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Payments from trust and other funds—Continued.		
Watson fund—		
Mrs. A. H. Watson	$300.00	
J. A. Miller	370.00	
H. C. Wilson	300.00	
Watson medal, A. O. Leuschner	138.00	
Watson honorarium, A. O. Leuschner	100.00	
Transfer Bache to Marsh fund	472.50	
Elliot fund return to general fund	73.06	
Murray fund return to general fund	.08	
Marsh fund printing	2.65	
		9,464.81
Proceedings:		
Salary managing editor	750.00	
Printing and distributing	3,933.72	
Expenses office of editor	374.00	
Miscellaneous expenses	120.80	
		5,178.52
General fund:		
Salary assistant secretary and treasurer	600.00	
Treasurer's office	214.46	
Home secretary's office	710.39	
Foreign secretary's office	25.26	
Memoirs, printing, etc	277.75	
Meetings, annual	830.52	
Meetings, autumn	319.20	
Postage and telegrams	141.29	
Election of members	118.00	
International Association of Academies	34.35	
Panama Canal slide committee	86.69	
		3,357.91
		46,271.95
Cash balance Dec. 31, 1916:[1]		
Cash income balance		19,219.21
Uninvested capital		10,332.43
		75,823.59

Unpaid dues: 1916, $95.

[1] Three outstanding checks, $82.25.

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ACCOUNTS WITH INDIVIDUAL FUNDS JAN. 1 TO DEC. 31, 1916.

	General fund.		Building fund.	
	Income.	Capital.	Income.	Capital.
Balance Jan. 1, 1916:				
Cash	$2,139.95		$391.53	$1,510.00
Invested	4,700.00		1,562.50	5,490.00
Receipts:				
Interest on investments	2,237.95		349.88	
Murray fund return	.03			
Elliot fund return	73.06			
Transfer income to capital				2,292.53
Total	9,150.99		2,303.91	9,292.53
Disbursements:				
General expenses	3,298.03		11.38	
Depreciation valuation bonds				338.50
Advance to Elliot fund	73.06			
Panama committee expenses	86.69			
Transfer income to capital			2,292.53	
Balance Dec. 31, 1916:				
Cash	1,006.96			
Invested	4,686.25			8,954.03
Total	9,150.99		2,303.91	9,292.53
Investments made	996.25			1,835.00

	Agassiz fund.		Bache fund.	
	Income.	Capital.	Income.	Capital.
Balance Jan. 1, 1916:				
Cash		$100.00	$3,832.57	$82.05
Invested		49,900.00	2,575.00	55,917.95
Receipts:				
Interest on investments			2,466.73	
Transfer income to capital		25.00		351.45
Total		50,025.00	8,874.30	56,351.45
Disbursements:				
Depreciation valuation bonds		25.00		351.45
Warrant			4,576.00	
Transfer Bache to Marsh			472.50	
Transfer income to capital			351.45	
Balance Dec. 31, 1916:				
Cash			899.35	
Invested (including transfers to consolidated fund)		50,000.00	2,575.00	56,000.00
Total		50,025.00	8,874.30	56,351.45

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Accounts with individual funds Jan. 1 to Dec. 31, 1916—Continued.

	Comstock fund.		Draper fund.	
	Income.	Capital.	Income.	Capital.
Balance, Jan. 1, 1916:				
Cash	$708.82	$22.50	$1,247.06	.....
Invested	677.50	11,315.00	1,035.00	$10,000.00
Receipts:				
Interest on investments	588.50	.....	471.33	.....
Total	1,974.82	11,337.50	2,753.39	10,000.00
Disbursements:				
General expenses	.....	.....	5.70	.....
Warrants	.....	.....	550.00	.....
Balance, Dec. 31, 1916:				
Cash	1,297.32	22.50	245.19	.....
Invested	677.50	11,315.00	1,952.50	10,000.00
Total	1,974.82	11,337.50	2,753.39	10,000.00
Investments made	.....	.....	917.50	.....

	Elliot fund.		Gibbs fund.	
	Income.	Capital.	Income.	Capital.
Balance, Jan. 1, 1916:				
Cash	.....	.....	$345.77	$42.50
Invested	.....	.....	.....	5,457.50
Receipts:				
Interest on investments	$229.71	.....	226.48	.....
Margaret Henderson Elliot	.....	$8,000.00	.....	.....
Increase in value of bonds	.....	.....	.....	45.50
Total	229.71	8,000.00	572.25	5,545.50
Disbursements:				
General expenses	41.67	.....	.....	.....
Warrants	.....	.....	300.00	.....
Elliot fund return	73.06	.....	.....	.....
Balance, Dec. 31, 1916:				
Cash	114.98	.....	272.25	.....
Invested	.....	8,000.00	.....	5,545.50
Total	229.71	8,000.00	572.25	5,545.50

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Accounts with individual funds Jan. 1 to Dec. 31, 1916—Continued.

	Gould fund.		Marsh fund.	
	Income.	Capital.	Income.	Capital.
Balance Jan. 1, 1916:				
Cash	$859.65	$46.25	$271.88	$750.00
Invested	4,057.50	19,953.75	677.50	9,377.65
Receipts:				
Interest on investments	1,227.49	.....	368.38	.....
Grant A. H. Pfund returned	501.78	.....	.....	.....
Estate of O. C. Marsh	.....	.....	6,921.84	.....
Return interest, Bache to Marsh	.....	.....	472.50	.....
Transfer income to capital	.....	.....	.....	2.65
Total	6,646.42	20,000.00	8,712.10	10,130.30
Disbursements:				
General expenses	9.86	.....	.....	.....
Warrants	1,640.00	.....	.....	.....
Income to capital	.....	.....	2.65	.....
Capital to consolidated	.....	.....	.....	2.65
Balance Dec. 31, 1916:				
Cash	929.06	2,036.25	8,031.95	.....
Invested	4,067.50	17,963.75	677.50	10,127.65
Total	6,646.42	20,000.00	8,712.10	10,130.30
Transfer investment	1,020.00	.....	.....	.....
Investment made	.....	1,010.00	.....	.....
Investment paid	1,000.00	.....	.....	.....
Mortgage paid	.....	2,000.00	.....	.....

	Murray fund.		National research council.	
	Income.	Capital.	Income.	Capital.
Balance Jan. 1, 1916:				
Cash	.....	$35.00	.....	.....
Invested	.....	5,965.00	.....	.....
Receipts:				
Interest on investments	$275.00	.....	.....	.....
Contribution national research council	.....	.....	$50.00	.....
Total	275.00	6,000.00	50.00	.....
Disbursements:				
General expenses	.03	.....	.....	.....
Balance Dec. 31, 1916:				
Cash	274.97	35.00	50.00	.....
Invested	.....	5,965.00	.....	.....
Total	275.00	6,000.00	50.00	.....

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Accounts with individual funds Jan. 1 to Dec. 31, 1916—Continued.

	Smith fund.		Watson fund.	
	Income.	Capital.	Income.	Capital.
Balance Jan. 1, 1916:				
Cash	$762.27	$105.00	$92.65	$77.50
Invested	1,532.50	9,895.00	1,020.00	24,922.50
Receipts:				
Interest on investments	469.11		1,271.50	
Income to capital		90.00		
Total	2,763.88	10,090.00	2,384.15	25,000.00
Disbursements:				
General expenses			3.00	
Watson medal			135.00	
Watson honorarium			100.00	
Warrants	300.00		970.00	
Hartley income to capital	90.00			
Transfer to consolidated		90.00		
Balance Dec. 31, 1916:				
Cash	841.38		1,176.15	77.50
Invested	1,532.50	10,000.00		24,922.50
Total	2,763.88	10,090.00	2,384.15	25,000.00
Investment transferred			1,020.00	

	Proceedings.		Hale Lectureship.	
	Income.	Capital.	Income.	Capital.
Balance Jan. 1, 1916:				
Cash	$1,128.70		$300.00	
Invested	1,020.00			
Receipts:				
Interest on investments	45.84			
Contribution to Hale Lectureship			1,000.00	
Reprints	506.65			
Separate numbers	18.50			
Contributions to proceedings	2,178.33			
Subscriptions	773.87			
Annual dues	735.00			
Total	6,406.89		1,300.00	
Disbursements:				
General expenses	5,178.52			
Hale Lectureship honorarium			300.00	
Balance Dec. 31, 1916:				
Cash	1,228.37		1,000.00	
Invested				
Total	6,406.89		1,300.00	
Investment transferred	1,020.00			

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Accounts with individual funds Jan. 1 to Dec. 31, 1916—Continued.

	Hartley fund.		Consolidated fund.	
	Income.	Capital.	Income.	Capital.
Balance Jan. 1, 1916:				
Cash	$147.50	$148.00		
Invested		1,020.00		
Receipts:				
Interest on investments	38.55		$5,723.62	
Hartley income to capital		32.00		
Income to capital		2.50		
Total	186.05	1,202.50	5,723.62	
Disbursements:				
General expenses			57.50	
Hartley medal	42.57			
Hartley income to capital	34.50			
Distribution of consolidated interest			3,917.60	
Advance to building fund			6.22	
Transfer to consolidated		2.50		
Balance Dec. 31, 1916:				
Cash	108.98		1,742.30	$8,161.18
Invested		1,200.00		155,671.00
Total	186.05	1,202.50	5,723.62	163,832.18
Investments transferred			1,020.00	
Investments made				5,980.60
Mortgage paid				13,000.00

WHITMAN CROSS,
Treasurer.

JANUARY 2, 1917.

88121°—S. Doc. 707, 64-2——5

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REPORT OF THE AUDITING COMMITTEE.

WASHINGTON, D. C., *January 13, 1917.*

We hereby certify that we have examined the securities and papers contained in the box of the National Academy of Sciences at the American Security & Trust Co.'s building and have found them to correspond with the list checked by the auditing committee on January 14, 1916.

We find that the coupons due in 1916 have been cut and are accounted for; also that the coupons due January 1, 1917, have been detached and are accounted for by an appropriate entry in the pass book. We have accepted the certified statement of the Capital Audit Co. as to the correspondence between the vouchers, pass book, and accounts of the treasurer and as to the balance shown by the books of the treasurer on December 31, 1916, and certify to its agreement with the balance shown by the report of the treasurer, by his check book, and by the American Security & Trust Co.

W. H. DALL, *Chairman.*
ARTHUR L. DAY,
F. W. CLARKE.

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APPENDIXES.

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APPENDIX A.

CONSTITUTION OF THE NATIONAL ACADEMY.

As amended and adopted April 17, 1872, and further amended April 20, 1875; April 21, 1881; April 19, 1882; April 18, 1883; April 19, 1888; April 18, 1895; April 20, 1899; April 17, 1902; April 18, 1906; November 20, 1906; April 17, 1907; November 20, 1907; April 20, 1911; April 16, 1912; April 21, 1915.

PREAMBLE.

Empowered by the act of incorporation enacted by Congress, and approved by the President of the United States on the 3d day of March, A. D. 1863, and in conformity with amendments to said act approved July 14, 1870, June 20, 1884, and May 27, 1914, the National Academy of Sciences adopts the following amended constitution and rules:

ARTICLE I.—OF MEMBERS.

SECTION 1. The academy shall consist of members, honorary members, and foreign associates. Members must be citizens of the United States.

SEC. 2. Members who, from age or inability to attend the meetings of the academy, wish to resign the duties of active membership, may, at their own request, be transferred to the roll of honorary members by a vote of the academy.

SEC. 3. The academy may elect 50 foreign associates.

SEC. 4. Honorary members and foreign associates shall have the privilege of attending the meetings and of reading and communicating papers to the academy, but shall take no part in its business, shall not be subject to its assessments, and shall be entitled to a copy of the publications of the academy.

ARTICLE II.—OF THE OFFICERS.

SECTION 1. The officers of the academy shall be a president, a vice president, a foreign secretary, a home secretary, and a treasurer, all of whom shall be elected for a term of six years, by a majority of votes present, at the first stated meeting after the expiration of the current terms, provided that existing officers retain their places until their successors are elected. In case of a vacancy, the election for six years shall be held in the same manner at the meeting when such

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vacancy occurs, or at the next stated meeting thereafter, as the academy may direct. A vacancy in the office of treasurer or home secretary may, however, be filled by appointment of the president of the academy until the next stated meeting of the academy.

SEC. 2. The officers of the academy, together with six members to be elected by the academy, shall constitute a council for the transaction of such business as may be assigned to them by the constitution or the academy.

SEC. 3. The president of the academy, or, in case of his absence or inability to act, the vice president, shall preside at the meetings of the academy and of the council; shall name all committees except such as are otherwise especially provided for; shall refer investigations required by the Government of the United States to members especially conversant with the subjects and report thereon to the academy at its meeting next ensuing; and, with the council, shall direct the general business of the academy.

It shall be competent for the president, in special cases, to call in the aid, upon committees, of experts or men of special attainments not members of the academy.

The president shall be, *ex officio*, a member of all committees empowered to consider questions referred to the academy by the Government of the United States.

SEC. 4. The foreign and home secretaries shall conduct the correspondence proper to their respective departments, advising with the president and council in cases of doubt, and reporting their action to the academy at one of the stated meetings in each year.

It shall be the duty of the home secretary to give notice to the members of the place and time of all meetings, of all nominations for membership, and of all proposed amendments to the constitution.

It shall be the duty of the home secretary to keep the minutes of each business and scientific session, and after approval to enter these upon the permanent records of the academy.

SEC. 5. The treasurer shall attend to all receipts and disbursements of the academy, giving such bond and furnishing such vouchers as the council may require. He shall collect all dues, assessments, and subscriptions, and keep a set of books showing a full account of receipts and disbursements and the condition of all funds of the academy. He shall be the custodian of the corporate seal of the academy.

ARTICLE III.—OF THE MEETINGS.

SECTION 1. The academy shall hold one stated meeting in each year, called the annual meeting, in the city of Washington, beginning on the third Monday in April, and another, called the autumn meeting, to be held at such place and time as the council shall determine.

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Special business meetings of the academy may be called, by order of eight members of the council, at such place and time as may be designated in the call.

Special scientific meetings of the academy may be held at times and places to be designated by a majority of the council.

SEC. 2. The names of the members present at each session of a meeting shall be recorded in the minutes, and the members present at any session shall constitute a quorum for the transaction of business.

SEC. 3. Scientific sessions of the academy, unless otherwise ordered by a majority of the members present, shall be open to the public; sessions for the transaction of business shall be closed.

SEC. 4. Stated meetings of the council shall be held during the stated or special meetings of the academy and four members shall constitute a quorum for the transaction of business. Special meetings of the council may be convened at the call of the president and two members of the council, or of four members of the council.

SEC. 5. No member whose dues are in arrears shall vote at any business meeting of the academy.

ARTICLE IV.—OF ELECTIONS AND RESIGNATIONS.

SECTION 1. All elections of officers and members shall be by ballot, and each election shall be held separately.

SEC. 2. The time for holding an election of officers shall be fixed by the academy at least one day before the election is held.

SEC. 3. The election of the six members of the council shall be as follows:

At the annual meeting in April, 1907, six members of the council to be elected, of whom two shall serve for three years, two for two years, and two for one year, their respective terms to be determined by lot. Each year thereafter the terms of two members shall expire, and their successors, to serve for three years, shall be elected at the annual meeting in each year.

SEC. 4. The academy shall be divided by the council into sections representing the principal branches of scientific research. Each section shall elect its own chairman, who shall serve for three years. The chairman shall be responsible to the academy for the work of his section.

Nominations to membership in the academy shall be made in writing and approved by a majority of the members of the section on the branch of research in which the person nominated is eminent, or by a majority of the council in case there is no section on the subject. The nominations shall be sent to the home secretary by the chairman of the section before January 1 of the year in which the election is to be held, and each nomination shall be accompanied by a list of

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the principal contributions of the nominee to science. This list shall be printed by the home secretary for distribution among the members of the academy.

SEC. 5. Election of members shall be held at the annual meeting in Washington in the following manner: There shall be two ballots—a preference ballot, which may be prepared either before or at the annual meeting and must be transmitted to the home secretary, and a final ballot, to be taken at the meeting.

Preference ballot.—Each member may inscribe on a ballot not more than 15 names of nominees selected from the submitted list. A list of the nominees shall then be prepared, on which the names shall be entered in the order of the number of votes received by each. In case two or more nominees have the same number of votes on this preference list, the order in which they shall be placed on the list shall be determined by a majority vote of members present.

Final ballot.—A vote shall first be taken on the nominee who appears first on the preference list, and he shall be declared elected if he receive two-thirds of the votes cast and not less than 25 votes in all. A vote shall then be taken in similar manner on the nominee standing second on the preference list, and so on until all the nominees on the preference list shall have been acted on, or until 15 nominees shall have been elected or until the total membership of the academy shall have reached 250.

Not more than 15 members shall be elected at one annual meeting.

Before and during elections a discussion of the merits of nominees will be in order.

SEC. 6. Every member-elect shall accept his membership, personally or in writing, before the close of the next stated meeting after the date of his election. Otherwise, on proof that the secretary has formally notified him of his election, his name shall not be entered on the roll of members.

SEC. 7. Foreign associates may be nominated by the council and may be elected at the annual meeting by a two-thirds vote of the members present.

SEC. 8. A diploma, with the corporate seal of the academy and the signatures of the officers, shall be sent by the appropriate secretary to each member on his acceptance of membership, and to foreign associates on their election.

SEC. 9. Resignations shall be addressed to the president and acted on by the academy.

SEC. 10. Whenever a member has not paid his dues for four successive years, the treasurer shall report the fact to the council, which may report the case to the academy with the recommendation that the person thus in arrears be declared to have forfeited his membership. If this recommendation be approved by two-thirds of the members

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present, the said person shall no longer be a member of the academy and his name shall be dropped from the roll.

ARTICLE V.—SCIENTIFIC COMMUNICATIONS, PUBLICATIONS, AND REPORTS.

SECTION 1. Communications on scientific subjects shall be read at scientific sessions of the academy, and papers by any member may be read by the author or by any other member, notice of the same having been previously given to the secretary.

SEC. 2. Any member of the academy may read a paper from a person who is not a member, and shall not be considered responsible for the facts or opinions expressed by the author, but shall be held responsible for the propriety of the paper.

Persons who are not members may read papers on invitation of the council or of the committee of arrangements.

SEC. 3. The academy may provide for the publication, under the direction of the council, of proceedings, scientific memoirs, biographical memoirs, and reports.

The proceedings shall include the transactions of the academy, brief original announcements of the results of scientific investigations made by members of the academy or others, together with short original articles giving a comprehensive survey of the more important scientific researches currently made by American investigators, and other matters of general scientific interest.

The scientific memoirs shall provide opportunity for the publication of longer and more detailed scientific investigations.

The biographical memoirs shall contain an appropriate record of the life and work of deceased members of the academy.

An annual report shall be presented to Congress by the president and shall contain the annual reports of the treasurer and the auditing committee, a suitable summary of the reports of the committees in charge of trust funds, and a record of the activities of the academy for the calendar year immediately preceding, and other appropriate matter. This report shall be presented to Congress by the president after authorization by the council. It shall also be presented to the academy at the annual meeting next following.

The treasurer shall prepare a full report of the financial affairs of the academy at the end of the fiscal year. This report shall be submitted to the council for approval and afterwards presented to the academy at the annual meeting.

SEC. 4. Propositions for investigations or reports by the academy shall be submitted to the council for approval, except those requested by the Government of the United States, which shall be acted on by the president, who will in such cases report their results to the Government as soon as obtained and to the academy at its next following stated meeting.

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SEC. 5. The advice of the academy shall be at all times at the disposition of the Government upon any matter of science or art within its scope.

ARTICLE VI.—OF THE PROPERTY OF THE ACADEMY.

SECTION 1. All investments and reinvestments of either principal or accumulations of income of the trust and other funds of the academy shall be made by the treasurer, with the approval of the finance committee, in the corporate name of the academy, in the manner and in the securities designated or specified in the instruments creating the several funds, or, in the absence of such designation or specification, in bonds of the United States or of the several States, or in bonds or notes secured by first mortgages on real estate, in investments legal for savings banks under the laws of Massachusetts or New York, or in other bonds recommended to the treasurer by the fiscal advisers of the academy.

The treasurer may invest the capital of all trust funds of the academy which are not required by the instruments creating such funds to be kept separate and distinct, in a consolidated fund, and shall apportion the income received from such consolidated fund among the various funds composing the same in the proportion that each of said funds shall bear to the total amount of funds so invested; provided, however, that the treasurer shall at all times keep accurate accounts showing the amount of each trust fund, the proportion of the income from the consolidated fund to which it is entitled, and the expenses and disbursements properly chargeable to such fund.

SEC. 2. The council shall at its annual meeting in each year designate one bank or trust company in Washington, D. C., and one in New York City, to act, when requested by the treasurer, as the fiscal advisers of the academy.

SEC. 3. The treasurer shall have authority, with the approval of the finance committee, to sell, transfer, convey, and deliver in the corporate name and for the benefit of the academy any stocks, bonds, or other securities standing in the corporate name.

SEC. 4. No contract shall be binding upon the academy which has not been first approved by the council.

SEC. 5. The assessments required for the support of the academy shall be fixed by the academy on the recommendation of the council and shall be payable within the calendar year for which they are assessed.

ARTICLE VII.—OF TRUST FUNDS AND THEIR ADMINISTRATION.

SECTION 1. Devises, bequests, donations, or gifts having for their object the promotion of science or the welfare of the academy may be accepted by the council for the academy. Before the acceptance

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of any such trust the council shall consider the object of the trust and all conditions or specifications attaching thereto. The council shall make a report of its action to the academy.

SEC. 2. Medals and prizes may be established in accordance with the provisions of trusts or by action of the academy.

SEC. 3. Unless otherwise provided by the deed of gift, the income of each trust fund shall be applied to the objects of that trust by the action of the academy on the recommendation of a standing committee on that fund.

ARTICLE VIII.—OF ADDITIONS AND AMENDMENTS.

Additions and amendments to the constitution shall be made only at a stated meeting of the academy. Notice of a proposition for such a change must be submitted to the council, which may amend the proposition, and shall report thereon to the academy. Its report shall be considered by the academy in committee of the whole for amendment.

The proposition as amended, if adopted in committee of the whole, shall be voted on at the next stated meeting, and if it receives two-thirds of the votes cast it shall be declared adopted.

Absent members may send their votes on pending changes in the constitution to the home secretary in writing, and such votes shall be counted as if the members were present.

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APPENDIX B.

RULES.

(In accordance with a resolution of the academy, taken at its meeting on April 21, 1915, the rules are arranged in groups and each group is numbered to correspond with the article of the constitution to which it relates.)

I.

1. The holders of the medal for eminence in the application of science to the public welfare shall be notified, like members, of the meetings of the academy, and invited to participate in its scientific sessions.

II.

1. The proper secretary shall acknowledge all donations made to the academy, and shall at once report them to the council for its consideration.

2. The home secretary shall be the custodian of all books, apparatus, archives, and collections not explicitly assigned to other care.

3. The home secretary shall keep a record of all grants of money or awards of prizes or medals made from trust funds of the academy. The record for each grant of money shall include the following items:

1. Name of fund.
2. Date and number of the grant.
3. Name and address of recipient.
4. Amount of grant and date or dates of payment.
5. Purpose of grant.
6. Record or report of progress.
7. Resulting publications.

4. The treasurer shall keep the home secretary informed of all warrants received from directors of trust funds not controlled by the academy and of the date or dates of payment of all warrants.

5. The treasurer is authorized to defray, when approved by the president, all the proper expenses of committees appointed to make scientific investigations at the request of departments of the Government, and in each case to look to the department requesting the investigation for reimbursement to the academy.

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III.

1. At the business sessions of the academy the order of procedure shall be as follows:

1. Chair taken by the president, or, in his absence, by the vice president.
2. Roll of members called by home secretary (first session of the meeting only).
3. Minutes of the preceding session read and approved.
4. Stated business.
5. Reports of president, secretaries, treasurer, and committees.
6. Business from council.
7. Other business.

2. The rules of order of the academy shall be those of the Senate of the United States, unless otherwise provided by the constitution or rules of the academy.

3. In the absence of any officer a member shall be chosen to perform his duties temporarily, by a plurality of *viva voce* votes, upon open nomination.

4. At each meeting the president shall announce the death of any members since the preceding meeting. As soon as practicable thereafter he shall designate a member to write—or to secure from some other source approved by the president—a biographical notice of each deceased member.

5. A standing committee of three members called the program committee, a local committee of five members appointed for each meeting, and the home secretary shall together constitute the committee of arrangements, of which the home secretary shall be chairman.

The term of service on the program committee shall be three years, one member retiring annually, the chairman to be designated by the president.

It shall be the duty of the program committee to prepare the scientific program for the annual meeting, and for this purpose it shall be empowered to solicit papers from members or others. It shall also be empowered to ascertain the length of time required for reading papers to be presented at the scientific sessions of the academy, and, when it appears advisable, to limit the time to be occupied in their presentation or discussion.

The local committee shall meet not less than two months previous to each meeting. It shall prepare the detailed program of each day, and in general shall have charge of all business and scientific arrangements for the meeting for which it is appointed except those specifically assigned to the program committee in the case of the annual meeting.

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IV.

1. The term of service of each chairman of a section shall be three years, to date from the closing session of the April meeting next following his election. Chairmen of sections shall be chosen by mail ballot, the member receiving the highest number of votes cast to be deemed elected. It shall be the duty of each retiring chairman to conduct the election of his successor and to report the result of the election to the home secretary before the April meeting at which his term of service expires. Should any section fail to elect a chairman before November 1, the president is empowered to appoint a temporary chairman to serve until the April meeting next following. No chairman shall be eligible for reelection for two consecutive terms.

2. The chairman of each section of the academy shall submit to the members of his section, not later than November 1 of each year, a ballot containing the names of all those persons who received not less than two votes in the nominating ballot of the preceding year and of any other persons who were newly proposed for consideration at that time. Each member of the section shall be expected to return this ballot to the chairman within two weeks with his signature and with crosses placed against the names of those persons whom he is prepared to endorse for nomination. Each member may also write upon the ballot in a place provided for the purpose any new names which he desires to have included in the ballot to be submitted to the section in the following year. The vote resulting from this ballot shall be regarded as informal.

The chairman shall then submit to the members of his section a new ballot showing the results of the informal vote; and each member shall be expected to return this ballot to the chairman with his signature and with crosses placed against the names of those persons whom he will endorse for nomination. In order to secure an adequate number of nominations, the chairman, when necessary, shall obtain by personal solicitation a fuller vote of his section or shall submit to the section a supplementary formal ballot.

The chairman shall then certify to the home secretary, prior to January 1, the names of those persons who have been voted for on the formal ballots by a majority of the members of the section, and shall furnish him a list of the publications of these nominees, as required by the constitution.

3. Nominations for membership shall give the full name, residence, and the official positions successively held by the candidate, in addition to the list of his contributions to science required by the constitution.

4. Preference ballots for election of members shall be sealed in a blank envelope, which shall be inclosed in another bearing the name

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of the sender, and which shall be addressed to the home secretary. Such envelopes shall be opened only by the tellers. If in any case the tellers are unable to determine who cast a ballot, or if the latter contains more names than are to be voted for, the ballot shall be rejected, but minor defects in a ballot shall be disregarded when the intent of the voter is obvious.

5. All discussions of the claims and qualifications of nominees at meetings of the academy shall be held strictly confidential, and remarks and criticisms then made may be communicated to no person who was not a member of the academy at the time of the discussion.

V.

1. The publication of the proceedings shall be under the general charge of the council, which shall have final jurisdiction upon all questions of policy relating thereto. The preparation of the proceedings for publication shall be entrusted to an editorial board. This board shall consist of a chairman and a managing editor, both of whom shall be appointed by the council for definite terms of service; of the home secretary and foreign secretary *ex officiis*, and of a body of associate editors representing the various branches of science which are to be included in the scope of the proceedings. The managing editor, who may be a nonmember of the academy, shall receive a salary, which shall be fixed by the council. It shall be the duty of the managing editor to prepare the proceedings in detail for publication; but the chairman of the editorial board shall decide, in consultation with the managing editor, in regard to the acceptance, rejection, or substantial modification of papers offered for publication. The associate editors shall be appointed by the council, upon recommendation of the chairman of the editorial board, for a period of three years, one-third of them retiring annually. The home secretary and the foreign secretary shall be responsible for the distribution of the proceedings in their respective fields.

2. Memoirs may be presented at any time to the home secretary, who shall report the date of their reception at the next session; but no memoir shall be published unless it has been read or presented by title before the academy.

Before publication all biographical and scientific memoirs must be referred to the committee on publication, who may, if they deem best, refer any memoir to a special committee appointed by the president to determine whether the same should be published by the academy.

3. Memoirs shall date, in the records of the academy, from the date of their presentation to the academy, and the order of their presentation shall be so arranged by the secretary that, so far as may be convenient, those upon kindred topics shall follow one another.

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4. The annual report of the treasurer shall contain:

1. A concise statement of the source, object, and amount of all trust funds of the academy.

2. A condensed statement of receipts and expenditures.

3. A statement of assets and liabilities.

4. Accounts with individual funds.

5. Such other matter as he considers appropriate.

5. The accounts of the treasurer shall, between January 1 and January 15 of each year, be audited by a committee of three members to be appointed by the president at the autumn meeting of the academy. It shall be the duty of the auditing committee to verify the record of receipts and disbursements maintained by the treasurer and the agreement of book and bank balances; to examine all securities in the custody of the treasurer and to compare the stated income of such securities with the receipts of record; to examine all vouchers covering disbursements for account of the academy and the authority therefor and to compare them with the treasurer's record of expenditures; to examine and verify the account of the academy with each trust fund. The auditing committee may employ an expert accountant to assist the committee in the examination of the books of the treasurer. The annual report of the treasurer shall be published with that of the president to Congress. The reports of the treasurer and auditing committee shall be presented to the academy at the annual meeting.

VI.

1. All apparatus and other materials of permanent value purchased with money from any grant from a trust fund shall be the property of the academy unless specific exception is made in the grant or by subsequent action of the council or the directors of the trust fund concerned. Receipts for all such property shall be signed by the grantee and shall be forwarded to the home secretary. All apparatus and unused material of value acquired in this way shall be delivered to the home secretary on completion of the investigation for which the grant was made, or at any time on demand of the council, and the home secretary shall give an appropriate release therefor.

2. The books, apparatus, archives, and other collections of the academy shall be deposited in some safe place in the city of Washington. A list of the articles so deposited shall be kept by the home secretary, who is authorized to employ a clerk to take charge of them.

3. A stamp corresponding to the corporate seal of the academy shall be kept by the secretaries, who shall be responsible for the due marking of all books and other objects to which it is applicable.

Labels or other proper marks of similar device shall be placed upon objects not admitting of the stamp.

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4. The fiscal year of the academy shall end on December 31 of each year.

5. The standing committee on finance shall consist of the treasurer *ex officio* as chairman and two members to be appointed annually by the president.

VII.

1. Standing committees of the academy on trust funds the income of which is applied to the promotion of research shall consist of three or five members. In order to secure rotation in office in such committees, when not in conflict with the provisions of the deeds of gift, the term of service on a committee of three members shall be three years; on a committee of five members the term shall be five years.

2. The annual reports of the committees on research funds shall, so far as the academy has authority to determine their form, give a current number to each award, stating the name, position, and address of the recipient, the subject of research for which the award is made, and the sum awarded; and in later annual reports the status of the work accomplished under each award previously made shall be announced, until the research is completed, when announcement of its completion and, if published, the title and place of publication shall be stated, and the record of the award shall be reported as closed.

VIII.

1. Any rule of the academy may be amended, suspended, or repealed on the written motion of any two members, signed by them, and presented at a stated meeting of the academy, provided the same shall be approved by a majority of the members present.

88121°—S. Doc. 707, 64-2——6

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APPENDIX C.

ORGANIZATION OF THE ACADEMY, 1916–17.

	Expiration of term.
WELCH, WILLIAM H., *President*	April, 1919
WALCOTT, CHARLES D., *Vice-President*	April, 1919
HALE, GEORGE E., *Foreign Secretary*	April, 1922
DAY, ARTHUR L., *Home Secretary*	April, 1919
CROSS, WHITMAN, *Treasurer*	April, 1917

ADDITIONAL MEMBERS OF COUNCIL.

1914–1917.

CONKLIN, E. G. — NOYES, A. A.

1915–1918.

COULTER, J. M. — HOWELL, W. H.

1916–1919.

CHITTENDEN, R. H. — PUPIN, M. I.

SECTIONS.

1. MATHEMATICS.

BLISS, G. A.
BÔCHER, MAXIME
BOLZA, OSKAR
DICKSON, L. E.
MOORE, E. H.
OSGOOD, W. F.
STORY, W. E.
VAN VLECK, E. B. (*Chairman, 1916–1919*)
WHITE, H. S.

2. ASTRONOMY.

ABBOT, C. G.
BARNARD, E. E.
CAMPBELL, W. W.
COMSTOCK, G. C.
ELKIN, W. L.
FROST, E. B.
HALE, G. E.
LEUSCHNER, A. O.
MOULTON, F. R.
PICKERING, E. C. (*Chairman, 1916–1919*)
SCHLESINGER, FRANK

3. PHYSICS.

ABBOT, H. L.
AMES, J. S.
BARUS, CARL
BELL, A. G.
BUMSTEAD, H. A.
CREW, HENRY
HALL, E. H.
HASTINGS, C. S.
HAYFORD, J. F.
MENDENHALL, T. C.
MERRITT, ERNEST
MICHELSON, A. A.
MILLIKAN, R. A.
NICHOLS, E. F. (*Chairman, 1916–1919*)
NICHOLS, E. L.
PUPIN, M. I.
ROSA, E. B.
THOMSON, ELIHU
TROWBRIDGE, JOHN
WEBSTER, A. G.
WOOD, R. W.
WOODWARD, R. S.

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4. CHEMISTRY.

BAXTER, G. P.
BOGERT, M. T.
BOLTWOOD, B. B.
CHANDLER, C. F.
CLARKE, F. W.
CRAFTS, J. M.
FRANKLIN, E. C.
GOMBERG, MOSES
GOOCH, F. A.
HILLEBRAND, W. F.
JACKSON, C. L.
LEWIS, G. N.
MICHAEL, ARTHUR
MORLEY, E. W.
MORSE, H. N.
NOYES, A. A.
NOYES, W. A.
OSBORNE, T. B.
REMSEN, IRA
RICHARDS, T. W. (*Chairman, 1916–1919*)
SMITH, ALEXANDER
SMITH, EDGAR F.
STIEGLITZ, JULIUS
WELLS, H. L.

5. GEOLOGY AND PALEONTOLOGY.

BECKER, G. F.
BRANNER, J. C.
CHAMBERLIN, T. C.
CLARK, W. B. (*Chairman, 1916–1919*)
CLARKE, J. M.
CROSS, WHITMAN
DALL, W. H.
DANA, E. S.
DAVIS, W. M.
DAY, A. L.
GILBERT, G. K.
HAGUE, ARNOLD
IDDINGS, J. P.
KEMP, J. F.
LINDGREN, WALDEMAR
OSBORN, H. F.
PIRSSON, L. V.
PUMPELLY, RAPHAEL
RANSOME, F. L.
REID, H. F.
SCHUCHERT, CHARLES
SCOTT, W. B.
VAN HISE, C. R.
WALCOTT, C. D.
WHITE, DAVID
WILLISTON, S. W.

6. BOTANY.

BRITTON, N. L.
CAMPBELL, D. H.
COULTER, J. M. (*Chairman, 1915–1918*)
FARLOW, W. G.
GOODALE, G. L.
HARPER, R. A.
SARGENT, C. S.
SMITH, ERWIN F.
THAXTER, ROLAND
TRELEASE, WILLIAM

7. ZOOLOGY AND ANIMAL MORPHOLOGY.

ALLEN, J. A.
CASTLE, W. E.
CONKLIN, E. G.
DAVENPORT, C. B.
DONALDSON, H. H.
HARRISON, R. G.
HOWARD, L. O.
JENNINGS, H. S.
LILLIE, F. R.
MALL, F. P.
MARK, E. L.
MAYER, A. G.
MERRIAM, C. H.
MORGAN, T. H.
MORSE, E. S.
PARKER, G. H. (*Chairman, 1916–1919*)
VERRILL, A. E.
WHEELER, W. M.
WILSON, EDMUND B.

8. PHYSIOLOGY AND PATHOLOGY.

ABEL, J. J.
BENEDICT, F. G.
CANNON, W. B.
CHITTENDEN, R. H.
COUNCILMAN, W. T.
FLEXNER, SIMON
FOLIN, OTTO
HOWELL, W. H. (*Chairman, 1916–1919*)
LEVENE, P. A. T.
LOEB, JACQUES
LUSK, GRAHAM
MELTZER, S. J.
MENDEL, L. B.
PEARL, RAYMOND
PRUDDEN, T. M.
SMITH, THEOBALD
VAUGHAN, V. C.
WELCH, W. H.
WOOD, H. C.

9. ANTHROPOLOGY AND PSYCHOLOGY.

BOAS, FRANZ
CATTELL, J. McK. (*Chairman, 1916–1919*)
DEWEY, JOHN
FEWKES, J. W.
HALL, G. S.
HOLMES, W. H.

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STANDING COMMITTEES.

ON WEIGHTS, MEASURES, AND COINAGE.

MENDENHALL, T. C. (*Chairman*) MICHELSON, A. A. MORLEY, E. W.
WEBSTER, A. G. WOODWARD, R. S.

ON SOLAR RESEARCH.

HALE, G. E. (*Chairman*) CAMPBELL, W. W. MICHELSON, A. A.
NICHOLS, E. L. PICKERING, E. C.

ON PUBLICATION.

The PRESIDENT. The HOME SECRETARY. WALCOTT, C. D.

EDITORIAL BOARD OF THE PROCEEDINGS.

PEARL, RAYMOND (*Chairman*) WILSON, EDWIN B. (*Managing Editor*)
DAY, A. L. (*Home Secretary*) HALE, G. E. (*Foreign Secretary*)

ABEL, J. J., 1918.	FROST, E. B., 1917.	MAYER, A. G., 1919.
CLARKE, J. M., 1918.	HARPER, R. A., 1919.	MILLIKAN, R. A., 1918.
CONKLIN, E. G., 1917.	HOLMES, W. H., 1917.	MOORE, E. H., 1917.
DAVENPORT, C. B., 1917.	IDDINGS, J. P., 1918.	NOYES, A. A., 1919.
DONALDSON, H. H., 1919.	LUSK, GRAHAM, 1919.	SMITH, ALEXANDER, 1918.

ON COLLECTION OF HISTORICAL PORTRAITS, MANUSCRIPTS, INSTRUMENTS, ETC.

WALCOTT, C. D. (*Chairman*) CLARKE, F. W. HAGUE, ARNOLD
HALE, G. E. MELTZER, S. J. PUPIN, M. I.

ON PROGRAM.

BOLTWOOD, B. B. (*Chairman*), 1918 CATTELL, J. McK., 1919
FROST, E. B., 1917.

FINANCE COMMITTEE.

CROSS, WHITMAN (*Chairman*) HAGUE, ARNOLD WALCOTT, C. D.

TRUST FUNDS.

THE BACHE FUND.

[$56,000.]

Researches in physical and natural science.

FROST, E. B. (*Chairman*) HARRISON, R. G. WEBSTER, A. G.

THE WATSON FUND.

[$25,000.]

Watson medal and the promotion of astronomical research.

FROST, E. B. (*Chairman*) COMSTOCK, G. C. ELKIN, W. L.

THE HENRY DRAPER FUND.

[$10,000.]

Draper medal and investigations in astronomical physics.

CAMPBELL, W. W. (*Chairman*), 1919. ABBOT, C. G., 1921. AMES, J. S., 1920.
HALE, G. E., 1918. MICHELSON, A. A., 1917.

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THE J. LAWRENCE SMITH FUND.

[$10,000.]

J. Lawrence Smith medal and investigations of meteoric bodies.

MORLEY, E. W. (*Chairman*), 1919. DANA, E. S., 1918. HAGUE, ARNOLD, 1917.
PICKERING, E. C., 1920. WOOD, R. W., 1921.

THE BARNARD MEDAL.[1]

Meritorious service to science.

WOODWARD, R. S. (*Chairman*) CAMPBELL, W. W. NICHOLS, E. F.
NOYES, A. A. RICHARDS, T. W.

THE BENJAMIN APTHORP GOULD FUND.

[$20,000.]

Researches in astronomy.

MOULTON, F. R. (*Chairman*) BARNARD, E. E. WOODWARD, R. S.

THE WOLCOTT GIBBS FUND.

[$5,545.50.]

Chemical research.

JACKSON, C. L. (*Chairman*) RICHARDS, T. W. SMITH, EDGAR F.

THE COMSTOCK FUND.

[$11,887.50.]

Researches in electricity, magnetism, and radiant energy.

NICHOLS, E. L. (*Chairman*), 1918. MILLIKAN, R. A., 1921. NOYES, A. A., 1919.
THOMSON, ELIHU, 1920. WEBSTER, A. G., 1917.

THE MARSH FUND.

[$10,127.65.]

Original research in the natural sciences.

MOORE, E. H. (*Chairman*), 1919. DANA, E. S., 1917.

SCHUCHERT, CHARLES, 1918.

THE AGASSIZ FUND.

[$50,000.]

General uses of the Academy.

THE MURRAY FUND.

[$6,000.]

Agassiz medal and contributions to oceanography.

DALL, W. H. (*Chairman*), 1918. DAVIS, W. M., 1919. PARKER, G. H., 1917.

THE MARCELLUS HARTLEY FUND.

[$1,200.]

Medal for eminence in the application of science to the public welfare.

BECKER, G. F. (*Chairman*), 1919. HILLEBRAND, W. F., 1919.
OSBORN, H. F., 1918. PUPIN, M. I., 1918. SMITH, THEOBALD, 1917.
WEBSTER, A. G., 1917.

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[1] Every five years the committee recommends the person whom they consider most deserving of the medal, and upon the approval of the Academy the name of the nominee is forwarded to the trustees of Columbia University, who administer the Barnard Medal Fund.

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THE JOSEPH HENRY FUND.

To assist meritorious investigators, especially in the direction of original research.

The sum of $40,000 was contributed by Fairman Rogers, Joseph Patterson, George W. Childs, and others, as an expression of their respect and esteem for Prof. Joseph Henry. This amount was deposited with the Pennsylvania Company for the Insurance of Lives and Granting Annuities in Trust, with authorization to collect the income thereon and to pay over the same to Prof. Joseph Henry during his natural life, and after his death to his wife and daughters, and after the death of the last survivor to "deliver the said fund and the securities in which it shall then be invested to the National Academy of Sciences, to be thenceforward forever held in trust under the name and title of the 'Joseph Henry Fund.'"

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MEMBERS OF THE NATIONAL ACADEMY OF SCIENCES.

DECEMBER 31, 1916.

		Date of election.
ABBOT, CHARLES GREELEY	*Smithsonian Institution, Washington, D. C.*	1915
ABBOT, HENRY L	*23 Berkeley St., Cambridge, Mass.*	1872
ABEL, JOHN JACOB	*Johns Hopkins University, Baltimore, Md.*	1912
ALLEN, J. ASAPH	*American Museum of Natural History, N. Y. City.*	1876
AMES, JOSEPH S	*Johns Hopkins University, Baltimore, Md.*	1909
BARNARD, E. E	*Yerkes Observatory, Williams Bay, Wis.*	1911
BARUS, CARL	*Brown University, Providence, R. I.*	1892
BAXTER, GREGORY PAUL	*T. J. Coolidge Jr. Mem. Lab., Cambridge, Mass.*	1916
BECKER, GEORGE F	*U. S. Geological Survey, Washington, D. C.*	1901
BELL, A. GRAHAM	*1331 Connecticut Ave., Washington, D. C.*	1883
BENEDICT, FRANCIS GANO	*Nutrition Laboratory, Boston, Mass.*	1914
BLISS, GILBERT AMES	*University of Chicago, Chicago, Ill.*	1916
BOAS, FRANZ	*Columbia University, New York City.*	1900
BOGERT, MARSTON TAYLOR	*Columbia University, New York City.*	1916
BÔCHER, MAXIME	*Harvard University, Cambridge, Mass.*	1909
BOLTWOOD, B. B	*Yale University, New Haven, Conn.*	1911
BOLZA, OSKAR	*Reichsgrafenstr. 10, Freiburg, Germany.*	1909
BRANNER, JOHN C	*Stanford University, California.*	1905
BRITTON, NATHANIEL LORD	*New York Botanical Gardens, N. Y. City.*	1914
BUMSTEAD, HENRY ANDREWS	*Yale University, New Haven, Conn.*	1913
CAMPBELL, D. H	*Stanford University, California.*	1910
CAMPBELL, WILLIAM W	*Lick Observatory, Mount Hamilton, California.*	1902
CANNON, WALTER BRADFORD	*Harvard University, Cambridge, Mass.*	1914
CASTLE, WILLIAM ERNEST	*186 Payson Road, Belmont, Mass.*	1915
CATTELL, JAMES MCK	*Garrison, N. Y.*	1901
CHAMBERLIN, THOMAS CHROWDER	*University of Chicago, Chicago, Ill.*	1903
CHANDLER, CHARLES F	*Columbia University, New York City.*	1874
CHITTENDEN, RUSSELL H	*Sheffield Scientific School, New Haven, Conn.*	1890
CLARK, WILLIAM BULLOCK	*Johns Hopkins University, Baltimore, Md.*	1908
CLARKE, F. W	*U. S. Geological Survey, Washington, D. C.*	1909
CLARKE, J. M	*State Hall, Albany, N. Y.*	1909
COMSTOCK, GEORGE C	*Washburn Observatory, Madison, Wis.*	1899
CONKLIN, E. G	*Princeton, N. J.*	1908
COULTER, J. M	*University of Chicago, Chicago, Ill.*	1909
COUNCILMAN, WILLIAM T	*Harvard Medical School, Boston, Mass.*	1904
CRAFTS, JAMES M	*19 Commonwealth Ave., Boston, Mass.*	1872
CREW, HENRY	*Northwestern University, Evanston, Ill.*	1909
CROSS, WHITMAN	*U. S. Geological Survey, Washington, D. C.*	1908
DALL, WILLIAM H	*Smithsonian Institution, Washington, D. C.*	1897
DANA, EDWARD S	*Yale University, New Haven, Conn.*	1884
DAVENPORT, CHARLES B	*Cold Spring Harbor, N. Y.*	1912
DAVIS, WILLIAM MORRIS	*31 Hawthorn St., Cambridge, Mass.*	1904
DAY, ARTHUR L	*Geophysical Laboratory, Washington, D. C.*	1911

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		Date of election.
DEWEY, JOHN	*Columbia University, New York City.*	1910
DICKSON, LEONARD E	*University of Chicago, Chicago, Ill.*	1913
DONALDSON, HENRY HERBERT	*Wistar Institute of Anatomy, Phila., Pa.*	1914
ELKIN, WILLIAM L	*Yale University Observatory, New Haven, Conn.*	1895
FARLOW, W. G	*Harvard University, Cambridge, Mass.*	1879
FEWKES, JESSE WALTER	*Bureau of American Ethnology, Wash., D. C.*	1914
FLEXNER, SIMON	*Rockefeller Institute, New York City.*	1908
FOLIN, OTTO	*Harvard Medical School, Boston, Mass.*	1916
FRANKLIN, EDWARD CURTIS	*Stanford University, California.*	1914
FROST, EDWIN B	*Yerkes Observatory, Williams Bay, Wis.*	1908
GILBERT, GROVE K	*U. S. Geological Survey, Washington, D. C.*	1883
GOMBERG, MOSES	*University of Michigan, Ann Arbor, Mich.*	1914
GOOCH, FRANK A	*Yale University, New Haven, Conn.*	1897
GOODALE, GEORGE L	*Harvard University, Cambridge, Mass.*	1890
HAGUE, ARNOLD	*U. S. Geological Survey, Washington, D. C.*	1885
HALE, GEORGE E	*Solar Observatory Office, Pasadena, Cal.*	1902
HALL, EDWIN H	*Harvard University, Cambridge, Mass.*	1911
HALL, GRANVILLE STANLEY	*Clark University, Worcester, Mass.*	1915
HARPER, R. A	*Columbia University, New York City.*	1911
HARRISON, ROSS G	*Yale University, New Haven, Conn.*	1913
HASTINGS, CHARLES S	*Yale University, New Haven, Conn.*	1889
HAYFORD, JOHN F	*Northwestern University, Evanston, Ill.*	1911
HILLEBRAND, WILLIAM F	*Bureau of Standards, Washington, D. C.*	1908
HOLMES, WILLIAM H	*U. S. National Museum, Washington, D. C.*	1905
HOWARD, LELAND OSSIAN	*U. S. Dept. of Agriculture, Washington, D. C.*	1916
HOWELL, WILLIAM H	*Johns Hopkins University, Baltimore, Md.*	1905
IDDINGS, JOSEPH P	*U. S. Geological Survey, Washington, D. C.*	1907
JACKSON, CHARLES L	*6 Boylston Hall, Cambridge, Mass.*	1883
JENNINGS, HERBERT SPENCER	*Johns Hopkins University, Baltimore, Md.*	1914
KEMP, JAMES F	*Columbia University, New York City.*	1911
LEUSCHNER, ARMIN O	*University of California, Berkeley, Cal.*	1913
LEVENE, PHŒBUS AARON THEODOR	*Rockefeller Institute, New York City.*	1916
LEWIS, GILBERT N	*University of California, Berkeley, Cal.*	1913
LILLIE, FRANK RATTRAY	*University of Chicago, Chicago, Ill.*	1915
LINDGREN, WALDEMAR	*Mass. Inst. of Technology, Boston, Mass.*	1909
LOEB, JACQUES	*Rockefeller Institute, New York City.*	1910
LUSK, GRAHAM	*Cornell University Medical College, New York City.*	1915
MALL, FRANKLIN P	*Johns Hopkins University, Baltimore, Md.*	1907
MARK, EDWARD L	*109 Irving St., Cambridge, Mass.*	1903
MAYER, ALFRED GOLDSBOROUGH	*Carnegie Institution, Maplewood, N. J.*	1916
MELTZER, SAMUEL JAMES	*Rockefeller Institute, New York City.*	1912
MENDEL, LAFAYETTE B	*18 Trumbull St., New Haven, Conn.*	1913
MENDENHALL, THOMAS C	*329 North Chestnut St., Ravenna, Ohio.*	1887
MERRIAM, C. HART	*1919 16th St., Washington, D. C.*	1902
MERRITT, ERNEST	*Cornell University, Ithaca, N. Y.*	1914
MICHAEL, ARTHUR	*219 Parker St., Newton Center, Mass.*	1889
MICHELSON, ALBERT A	*University of Chicago, Chicago, Ill.*	1888
MILLIKAN, ROBERT ANDREWS	*University of Chicago, Chicago, Ill.*	1915
MOORE, ELIAKIM H	*University of Chicago, Chicago, Ill.*	1901
MORGAN, T. H	*Columbia University, New York City.*	1909
MORLEY, EDWARD W	*West Hartford, Conn.*	1897
MORSE, EDWARD S	*Salem, Mass.*	1876

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		Date of election.
MORSE, HARMON N.	*Johns Hopkins University, Baltimore, Md.*	1907
MOULTON, F. R.	*University of Chicago, Chicago, Ill.*	1910
NICHOLS, EDWARD L.	*Cornell University, Ithaca, N. Y.*	1901
NICHOLS, ERNEST F.	*Yale University, New Haven, Conn.*	1908
NOYES, ARTHUR A.	*Massachusetts Institute of Technology, Boston, Mass.*	1905
NOYES, WILLIAM A.	*University of Illinois, Urbana, Ill.*	1910
OSBORN, H. F.	*American Museum of Natural History, New York City.*	1900
OSBORNE, T. B.	*Agricultural Experiment Station, New Haven, Conn.*	1910
OSGOOD, WILLIAM FOGG.	*Harvard University, Cambridge, Mass.*	1904
PARKER, GEORGE H.	*16 Berkeley St., Cambridge, Mass.*	1913
PEARL, RAYMOND.	*Maine Agricultural Experiment Station, Orono, Me.*	1916
PICKERING, EDWARD C.	*Harvard College Observatory, Cambridge, Mass.*	1873
PIRSSON, LOUIS V.	*41 Trumbull St., New Haven, Conn.*	1913
PRUDDEN T. MITCHELL.	*Columbia University, New York City.*	1901
PUMPELLY, RAPHAEL.	*Gibbs Ave., Newport, R. I.*	1872
PUPIN, MICHAEL I.	*Columbia University, New York City.*	1905
RANSOME, FREDERICK LESLIE.	*U. S. Geological Survey, Washington, D. C.*	1914
REID, H. FIELDING.	*Johns Hopkins University, Baltimore, Md.*	1912
REMSEN, IRA.	*Johns Hopkins University, Baltimore, Md.*	1882
RICHARDS, THEODORE W.	*Wolcott Gibbs Mem. Lab., Cambridge, Mass.*	1899
ROSA, EDWARD B.	*Bureau of Standards, Washington, D. C.*	1913
SARGENT, CHARLES S.	*Arnold Arboretum, Jamaica Plain, Mass.*	1895
SCHLESINGER, FRANK.	*Allegheny Observatory, Allegheny, Pa.*	1916
SCHUCHERT, CHARLES.	*Yale University, New Haven, Conn.*	1910
SCOTT, WILLIAM B.	*Princeton University, Princeton, N. J.*	1906
SMITH, ALEXANDER.	*Columbia University, New York City.*	1915
SMITH, EDGAR F.	*University of Pennsylvania, Philadelphia, Pa.*	1899
SMITH, ERWIN F.	*Bureau of Plant Industry, Washington, D. C.*	1913
SMITH, THEOBALD.	*Princeton, N. J.*	1908
STIEGLITZ, JULIUS.	*University of Chicago, Chicago, Ill.*	1911
STORY, WILLIAM E.	*Clark University, Worcester, Mass.*	1908
THAXTER, ROLAND.	*Harvard University, Cambridge, Mass.*	1912
THOMSON, ELIHU.	*Swampscott, Mass.*	1907
TRELEASE, WILLIAM.	*University of Illinois, Urbana, Ill.*	1902
TROWBRIDGE, JOHN.	*Harvard University, Cambridge, Mass.*	1878
VAN HISE, C. R.	*University of Wisconsin, Madison, Wis.*	1902
VAN VLECK, E. B.	*University of Wisconsin, Madison, Wis.*	1911
VAUGHAN, VICTOR CLARENCE.	*University of Michigan, Ann Arbor, Mich.*	1915
VERRILL, A. E.	*47 Cedar Grove Ave., New London, Conn.*	1872
WALCOTT, CHARLES D.	*Smithsonian Institution, Washington, D. C.*	1896
WEBSTER, ARTHUR G.	*Clark University, Worcester, Mass.*	1903
WELCH, WILLIAM H.	*507 St. Paul St., Baltimore, Md.*	1895
WELLS, HORACE L.	*Yale University, New Haven, Conn.*	1903
WHEELER, WILLIAM M.	*Harvard University, Cambridge, Mass.*	1912
WHITE, DAVID.	*U. S. Geological Survey, Washington, D. C.*	1912
WHITE, HENRY SEELY.	*Vassar College, Poughkeepsie, N. Y.*	1915
WILLISTON, SAMUEL WENDELL.	*University of Chicago, Chicago, Ill.*	1915
WILSON, EDMUND B.	*Columbia University, New York City.*	1899
WOOD, HORATIO C.	*4107 Chester Ave., Philadelphia, Pa.*	1879
WOOD, ROBERT W.	*Johns Hopkins University, Baltimore, Md.*	1912
WOODWARD, ROBERT S.	*Carnegie Institution, Washington, D. C.*	1896

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HONORARY MEMBER.

		Date of election.
SMITH, SIDNEY I.	*Yale University, New Haven, Conn.*	1884

FOREIGN ASSOCIATES.

ARRHENIUS, S. A.	*Nobelinstitut, Stockholm.*	1908
BAEYER, ADOLPH RITTER VON	*Universität, Munich.*	1898
BARROIS, CHARLES	*Université, Lille.*	1908
BRØGGER, W. C.	*Universitet, Christiania.*	1903
CROOKES, SIR WILLIAM	*London.*	1913
DARBOUX, GASTON	*Academy of Sciences, Paris.*	1913
DESLANDRES, HENRI	*Astrophysical Observatory, Meudon.*	1913
DEWAR, SIR JAMES	*University, Cambridge.*	1907
FISCHER, EMIL	*Chemisches Institut der Universität, Berlin.*	1904
FORSYTH, A. R.	*Imperial College of Science and Technology, London.*	1907
GEIKIE, SIR ARCHIBALD	*Haslemere, Surrey.*	1901
GROTH, PAUL VON	*Universität, Munich.*	1905
HEIM, ALBERT	*Zürich.*	1913
HILBERT, DAVID	*Universität, Göttingen.*	1907
KAPTEYN, JOHN C.	*Rijks Universiteit, Groningen.*	1907
KLEIN, FELIX	*Universität, Göttingen.*	1898
KÖSSEL, ALBRECHT	*Heidelberg.*	1913
KUSTNER, KARL FRIEDRICH	*Bonn.*	1913
LANKESTER, SIR E. RAY	*South Kensington, London.*	1908
LARMOR, SIR JOSEPH	*St. John's College, Cambridge.*	1908
LORENTZ, HENDRIK ANTON	*Rijks Universiteit, Leiden.*	1906
OSTWALD, WILHELM	*Grossbothen, bei Leipzig.*	1906
PAVLOV, IVAN PETROVITCH	*Imperial Institute for Experimental Medicine, Petrograd.*	1908
PENCK, ALBRECHT	*Universtät, Berlin.*	1909
PFEFFER, WILHELM	*Botanische Institut der Universität, Leipzig.*	1903
PICARD, CHARLES ÉMILE	*Université, Paris.*	1903
RAYLEIGH, LORD	*University, Cambridge.*	1898
RETZIUS, GUSTAV	*Högskolan, Stockholm.*	1909
RUTHERFORD, SIR ERNEST	*University, Manchester.*	1911
SCHUSTER, ARTHUR	*Secretary of the Royal Society, London.*	1913
SEELIGER, HUGO RITTER VON	*Universität, Munich.*	1908
THOMSON, SIR JOSEPH	*University, Cambridge.*	1903
VOLTERRA, VITO	*Università, Rome.*	1911
VRIES, HUGO DE	*Universiteit, Amsterdam.*	1904
WAALS, JOHANNES D. VAN DER	*Amsterdam.*	1913
WALDEYER, WILHELM	*Universität, Berlin.*	1909
WOLF, MAX F. J. C.	*Heidelberg.*	1913
WUNDT, WILHELM	*Universität, Leipzig.*	1909

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DECEASED MEMBERS.

	Date of election.	Date of death.
ABBE, CLEVELAND	1879 [2]	Oct. 28, 1916
AGASSIZ, ALEXANDER	1866	Mar. 27, 1910
AGASSIZ, LOUIS	(1)	Dec. 14, 1873
ALEXANDER, J. H	(1)	Mar. 2, 1867
ALEXANDER, STEPHEN	(1)	June 25, 1883
BACHE, ALEXANDER DALLAS	(1)	Feb. 14, 1867
BAIRD, SPENCER F	1864	Aug. 19, 1887
BARKER, GEORGE F	1876 [2]	May 24, 1910
BARNARD, F. A. P	(1) (2)	Apr. 27, 1889
BARNARD, J. G	(1)	May 14, 1882
BARTLETT, W. H. C	(1)	Feb. 11, 1893
BEECHER, CHARLES EMERSON	1899	Feb. 14, 1904
BILLINGS, JOHN S	1883 [2]	Mar. 11, 1913
BOSS, LEWIS	1889 [2]	Oct. 5, 1912
BOWDITCH, HENRY P	1887 [2]	Mar. 13, 1911
BREWER, WILLIAM H	1880 [2]	Nov. 2, 1910
BROOKS, WILLIAM KEITH	1884	Nov. 12, 1908
BROWN-SEQUARD, CHARLES E	1868	Apr. 2, 1894
BRUSH, GEORGE JARVIS	1868 [2]	Feb. 6, 1912
CASEY, THOMAS L	1890	Mar. 25, 1896
CASWELL, ALEXIS	(1)	Jan. 8, 1877
CHANDLER, SETH CARLO	1888 [2]	Dec. 31, 1913
CHAUVENET, WILLIAM	(1)	Dec. 13, 1870
CLARK, HENRY JAMES	1872	July 1, 1873
COFFIN, JAMES H	1869	Feb. 6, 1873
COFFIN, J. H. C	(1)	Jan. 8, 1890
COMSTOCK, CYRUS B	1884	May 29, 1910
COOK, GEORGE H	1887	Sept. 22, 1889
COOKE, JOSIAH P	1872	Sept. 3, 1894
COPE, EDWARD D	1872 [2]	Apr. 12, 1897
COUES, ELLIOTT	1877	Dec. 25, 1899
DALTON, J. C	1864	Feb. 2, 1889
DANA, JAMES D	(1) (2)	Apr. 14, 1895
DAVIDSON, GEORGE	1874 [2]	Dec. 2, 1911
DAVIS, CHARLES H	(1)	Feb. 18, 1877
DRAPER, HENRY	1877	Nov. 20, 1882
DRAPER, JOHN W	1877	Jan. 4, 1882
DUTTON, C. E	1884 [2]	Jan. 4, 1912
EADS, JAMES B	1872	Mar. 8, 1887
EMMONS, SAMUEL F	1892	Mar. 28, 1911
ENGELMANN, GEORGE	(1)	Feb. 4, 1884
FERREL, WILLIAM	1868	Sept. 18, 1891
FRASER, JOHN FRIES	(1)	Oct. 12, 1872
GABB, WILLIAM M	1876	May 30, 1878
GENTH, F. A	1872	Feb. 2, 1893
GIBBS, JOSIAH WILLARD	1879	Apr. 28, 1903
GIBBS, WOLCOTT	(1)	Dec. 9, 1908
GILL, THEODORE NICHOLAS	1873	Sept. 25, 1914
GILLISS, JAMES MELVILLE	(1)	Feb. 9, 1865
GOODE, G. BROWN	1888	Sept. 6. 1896
GOULD, AUGUSTUS A	(1)	Sept. 15, 1866
GOULD, BENJAMIN A	(1) (2)	Nov. 26, 1896
GRAY, ASA	(1)	Jan. 30, 1888
GUYOT, ARNOLD	(1)	Feb. 8, 1884

[1] Charter members, Mar. 3, 1863. [2] Biographical notices have not been presented.

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Deceased members—Continued.

	Date of election.	Date of death.
HADLEY, JAMES	1872	Nov. 14, 1872
HALDEMAN, S. S	1876	Sept. 20, 1880
HALL, ASAPH	1875	Nov. 22, 1907
HALL, JAMES	(1) (2)	Aug. 7, 1898
HAYDEN, F. V	1873	Dec. 22, 1887
HENRY, JOSEPH	(1)	May 13, 1878
HILGARD, EUGENE W	1872 [2]	Jan. 8, 1916
HILGARD, JULIUS E	(1)	May 9, 1890
HILL, GEORGE WILLIAM	1874	Apr. 16, 1914
HILL, HENRY B	1863	Apr. 6, 1903
HITCHCOCK, EDWARD	(1)	Feb. 27, 1864
HOLBROOK, J. E	1868	Sept. 8, 1871
HOLDEN, EDWARD SINGLETON	1895	Mar. 16, 1914
HUBBARD, J. S	(1)	Aug. 16, 1863
HUMPHREYS, A. A	(1)	Dec. 27, 1883
HUNT, T. STERRY	1873 [2]	Feb. 12, 1892
HYATT, ALPHEUS	1875	Jan. 15, 1902
JAMES, WILLIAM [3]	1903	Aug. 26, 1910
JOHNSON, S. W	1866	July 21, 1909
KEELER, J. E	1900	Aug. 12, 1900
KING, CLARENCE	1876	Dec. 24, 1901
KIRTLAND, JARED P	1865	Dec. 10, 1877
LANE, J. HOMER	1872	May 3, 1880
LANGLEY, SAMUEL P	1876	Feb. 27, 1906
LEA, MATTHEW CAREY	1892	Mar. 15, 1897
LE CONTE, JOHN	1878	Apr. 29, 1891
LE CONTE, JOHN L	(1)	Nov. 15, 1883
LE CONTE, JOSEPH	1875	July 6, 1901
LEIDY, JOSEPH	(1)	Apr. 30, 1891
LESLEY, J. PETER	(1)	June 1, 1903
LESQUEREUX, LEO	1864	Oct. 20, 1889
LONGSTRETH, MIERS F	(1)	Dec. 27, 1891
LOOMIS, ELIAS	1873	Aug. 15, 1889
LOVERING, JOSEPH	1873	Jan. 18, 1892
LYMAN, THEODORE	1872	Sept. 9, 1897
MAHAN, D. H	(1)	Sept. 16, 1871
MARSH, G. P	1866	July 23, 1882
MARSH, O. C	1874 [2]	Mar. 18, 1899
MAYER, ALFRED M	1872	July 13, 1897
MAYO-SMITH, RICHMOND	1890 [2]	Nov. 11, 1901
MEEK, F. B	1869	Dec. 21, 1876
MEIGS, M. C	1865	Jan. 2, 1892
MINOT, CHARLES SEDGWICK	1897 [2]	Nov. 19, 1914
MITCHELL, HENRY	1885 [2]	Dec. 1, 1902
MITCHELL, SILAS WEIR	1865 [2]	Jan. 4, 1914
MORGAN, LEWIS H	1875	Dec. 17, 1881
MORTON, HENRY	1874	May 9, 1902
NEF, JOHN ULRIC	1904 [2]	Aug. 13, 1915
NEWBERRY, J. S	(1)	Dec. 7, 1892
NEWCOMB, SIMON	1869 [2]	July 11, 1909
NEWTON, H. A	(1)	Aug. 12, 1896
NEWTON, JOHN	1876	May 1, 1895
NORTON, WILLIAM A	1873	Sept. 21, 1883

[1] Charter members, Mar. 3, 1863.
[2] Biographical notices have not been presented.
[3] Resigned in 1908 or 1909.

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Deceased members—Continued.

	Date of election.	Date of death.
OLIVER, JAMES E.	1872	Mar. 27, 1895
PACKARD, A. S.	1872 [2]	Feb. 14, 1905
PEIRCE, BENJAMIN [3]	(1) (3)	Oct. 6, 1880
PENFIELD, SAMUEL L.	1900	Aug. 13, 1906
PETERS, C. H. F.	1876 [2]	July 18, 1890
PIERCE, BENJAMIN OSGOOD	1906 [2]	Jan. 14, 1914
PIERCE, CHARLES SANTIAGO SANDERS	1876 [2]	Apr. 20, 1914
POURTALES, L. F.	1873	July 19, 1880
POWELL, JOHN W.	1880	Sept. 23, 1902
PUTNAM, FREDERICK W.	1885 [2]	Aug. 18, 1915
RODGERS, JOHN	(1)	May 5, 1882
ROGERS, FAIRMAN	(1)	Aug. 22, 1900
ROGERS, ROBERT E. [4]	(1)	Sept. 6, 1884
ROGERS, WILLIAM A.	1885	Mar. 1, 1898
ROGERS, WILLIAM B. [5]	(1)	May 30, 1882
ROOD, OGDEN N.	1865	Nov. 12, 1902
ROWLAND, HENRY A.	1881	Apr. 16, 1901
ROYCE, JOSIAH	1906 [2]	Sept. 14, 1916
RUTHERFURD, LEWIS M.	(1)	May 30, 1892
SAXTON, JOSEPH	(1)	Oct. 26, 1873
SCHOTT, CHARLES A.	1872	July 31, 1901
SCUDDER, SAMUEL H.	1877 [2]	May 17, 1911
SELLERS, WILLIAM	1873 [2]	Jan. 24, 1905
SILLIMAN, BENJ., Sr.	(1)	Nov. 24, 1864
SILLIMAN, BENJ., Jr.	(1)	Jan. 14, 1885
SMITH, J. LAWRENCE	1872	Oct. 12, 1883
STIMPSON, WILLIAM	1868 [2]	May 26, 1872
STRONG, THEODORE	(1)	Feb. 1, 1869
SULLIVANT, W. S.	1872	Apr. 30, 1873
TORREY, JOHN	(1)	Mar. 10, 1873
TOTTEN, J. G.	(1)	Apr. 22, 1864
TROWBRIDGE, WILLIAM P.	1872	Aug. 12, 1892
TRUMBULL, JAMES H.	1872	Aug. 5, 1897
TUCKERMAN, EDWARD	1868	Mar. 15, 1886
WALKER, FRANCIS A.	1878	Jan. 5, 1897
WARREN, G. K.	1876	Aug. 8, 1882
WATSON, JAMES C.	1868	Nov. 23, 1880
WATSON, SERENO	1880	Mar. 9, 1892
WHEELER, HENRY LORD	1909 [2]	Oct. 30, 1914
WHITE, CHARLES A.	1889	June 29, 1910
WHITMAN, C. O.	1895	Dec. 6, 1910
WHITNEY, JOSIAH D. [6]	(1) (3)	Aug. 19, 1896
WHITNEY, WILLIAM D. [6]	1865 [2]	June 9, 1894
WINLOCK, JOSEPH	(1)	June 11, 1875
WOODWARD, J. J.	1873	Aug. 17, 1884
WORTHEN, A. H.	1872	May 6, 1888
WRIGHT, ARTHUR WILLIAMS	1881	Dec. 19, 1915
WYMAN, JEFFRIES	(1)	Sept. 4, 1874
YOUNG, CHARLES A.	1872	Jan. 3, 1908

[1] Charter members, Mar. 3, 1863.
[2] Biographical notices have not been presented.
[3] Resigned 1878.
[4] Dropped —, reelected 1875.
[5] Dropped —, reelected 1872.
[6] Resigned.

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DECEASED FOREIGN ASSOCIATES.

ADAMS, J. C.
AIRY, SIR GEORGE B.
ARGELANDER, F. W. A.
AUWERS, G. F. J. ARTHUR
BACKLUND, OSKAR
BAER, KARL ERNEST VON
BARRANDE, JOACHIM
BEAUMONT, L. ÉLIE DE
BECQUEREL, HENRI
BERTHELOT, M. P. E.
BERTRAND, J. L. F.
BOLTZMANN, LUDWIG
BORNET, EDOUARD
BOUSSINGAULT, J. B. J. D.
BOVERI, THEODOR
BRAUN, ALEXANDER
BREWSTER, SIR DAVID
BUNSEN, ROBERT W.
BURMEISTER, C. H. C.
CANDOLLE, ALPHONSE DE
CAYLEY, ARTHUR
CHASLES, MICHEL
CHEVREUL, M. E.
CLAUSIUS, RUDOLPH
CORNU, ALFRED
DARWIN, SIR GEORGE HOWARD
DOVE, H. W.
DUMAS, J. B.
EHRLICH, PAUL
FARADAY, MICHAEL
GEGENBAUR, KARL
GLYDÉN, HUGO
GILL, SIR DAVID
HAMILTON, SIR WILLIAM ROWAN
HELMHOLTZ, BARON H. VON
HOFF, J. H. VAN'T
HOFMANN, A. W.
HOOKER, SIR JOSEPH D.
HUGGINS, SIR WILLIAM
HUXLEY, T. H.
IBAÑEZ, CARLOS
JANSSEN, J.
JOULE, JAMES P.
KEKULÉ, AUGUST
KELVIN, LORD
KIRCHOFF, G. R.
KOCH, ROBERT
KOHLRAUSCH, FRIEDRICH
KÖLLIKER, ALBERT VON
KRONECKER, HUGO
LACAZE-DUTHIERS, HENRI DE
LEUCKART, RUDOLPH
LIE, SOPHUS
LIEBIG, JUSTUS VON
LISTER, LORD
LOEWY, MAURICE
LUDWIG, K. F. W.
MAREY, E. J.
MENDELÉEFF, D. I.
MILNE-EDWARDS, HENRI
MOISSAN, HENRI
MURCHISON, SIR RODERICK I.
MURRAY, SIR JOHN
OPPOLZER, THEODORE VON
OWEN, SIR RICHARD
PASTEUR, LOUIS
PETERS, C. A. F.
PLANA, G. A. A.
POINCARÉ, JULES HENRI
RAMMELSBERG, C. F.
RAMSAY, SIR WILLIAM
REGNAULT, VICTOR
REYMOND, EMIL DU BOIS
RICHTHOFEN, F. VON
ROSENBUSCH, KARL HARRY FERDINAND
SACHS, JULIUS VON
SCHIAPARELLI, GIOVANNI
STAS, JEAN SERVAIS
STOKES, SIR GEORGE G.
STRASBURGER, EDOUARD
STRUVE, OTTO VON
SUESS, EDUARD
SYLVESTER, J. J.
TISSERAND, F. F.
VIRCHOW, RUDOLPH VON
VOGEL, H. C.
WEIERSTRASS, KARL
WEISMANN, AUGUST
WÖHLER, FRIEDRICH
WÜRTZ, ADOLPH
ZIRKEL, FERDINAND
ZITTEL, K. A. R. VON

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REPORT

OF THE

NATIONAL ACADEMY OF SCIENCES

FOR THE YEAR

1917

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1918

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REPORT

OF THE

NATIONAL ACADEMY OF SCIENCES

FOR THE YEAR

1917

WASHINGTON
GOVERNMENT PRINTING OFFICE
1918

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IN THE SENATE OF THE UNITED STATES,

March 8, 1918.

Resolved, That the report of the National Academy of Sciences for the year ending December 31, 1917, transmitted to the Senate on February 21, 1918, as provided for in the act approved March 3, 1863, be printed as a Senate document.

Attest:

JAMES M. BAKER,
Secretary.

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CONTENTS.

	Page.
Letter of transmittal	5
Act of incorporation	6
Amendments	7
Meetings of the National Academy, 1917	9
Annual meeting	9
Members in attendance	9
Business sessions	10
Announcement of deaths	10
Local committee	10
Finance committee of proceedings	10
Delegate	10
Report of the home secretary	10
Report of the foreign secretary	11
Report of the treasurer	11
Report of the directors of the Bache fund	11
Report of the trustees of the Watson fund	13
Report of the committee on the Henry Draper fund	14
Report of the committee on the J. Lawrence Smith fund	14
Report of the directors of the Wolcott Gibbs fund	14
Report of the committee on the Murray fund	15
Report of the committee on biographical memoirs	15
Daniel Giraud Eliot fund	16
Resignation of President Welch	16
Autumn meeting	17
Election of officers and members	17
Section and committee announcements	18
Trustees of the Watson fund	18
International academies	18
Platinum	19
Award of medal	19
Scientific sessions	20
April 16	20
April 17	20
April 18	21
Autumn meeting	21
Members in attendance	21
Business sessions	22
Announcement of deaths	22
Biographical memoirs	22
Editorial board	22
Section and committee announcements	22
Report of the editorial board	22
Institutions which have contributed three or more articles to proceedings each year	24
Summary of articles in first three volumes of proceedings	24
Auditing committee	24

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Meetings of the National Academy, 1917—Continued.
Autumn meeting—Continued.
Business sessions—Continued. Page.
Annual tables of constants ... 24
Engineering section ... 25
Classification of scientific men for war service ... 25
Report of the committee on the Comstock fund ... 29
Amendments to constitution and rules ... 29
The Watson fund ... 30
Proceedings deficit ... 30
Contributions to the support of the proceedings ... 30
Scientific sessions ... 31
November 20 ... 31
November 21 ... 32
Deceased members:
William Bullock Clark ... 33
Arnold Hague ... 36
Franklin Paine Mall ... 39
Adolf von Baeyer ... 41
Report of the National Research Council ... 46
Research information committee ... 48
Activities of committees ... 50
Financial support ... 53
War organization ... 54
Future of the National Research Council ... 64
Statement of contributions ... 65
Annual report of the treasurer ... 67
General review of financial transactions ... 67
Trust funds of the academy ... 68
Statement of assets and liabilities ... 69
Condensed statement of receipts and expenditures ... 72
Accounts with individual funds ... 74
Report of auditing committee ... 80
Appendixes ... 81
Appendix A—Constitution of the National Academy ... 83
Appendix B—Rules ... 90
Appendix C—Organization of the academy, 1916-17 ... 96
Sections ... 96
Standing committees ... 98
Trust funds ... 98
Members of the National Academy of Sciences, December 31, 1917. 101
Honorary members ... 104
Foreign associates ... 104
Deceased members ... 105
Deceased foreign associates ... 108

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LETTER OF TRANSMITTAL.

NATIONAL ACADEMY OF SCIENCES,
February 20, 1918.

The Honorable THOMAS R. MARSHALL,
Vice President of the United States,
Washington, D. C.

SIR: I have the honor to transmit to you herewith the annual report of the president of the National Academy of Sciences for the year ending December 31, 1917.

Very respectfully,

ARTHUR L. DAY,
Home Secretary.

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ACT OF INCORPORATION.

AN ACT To incorporate the National Academy of Sciences.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That Louis Agassiz, Massachusetts; J. H. Alexander, Maryland; S. Alexander, New Jersey; A. D. Bache, at large; F. B. Barnard,[1] at large; J. G. Barnard, United States Army, Massachusetts; W. H. C. Bartlett, United States Military Academy, Missouri; U. A. Boyden,[2] Massachusetts; Alexis Caswell, Rhode Island; William Chauvenet, Missouri; J. H. C. Coffin, United States Naval Academy, Maine; J. A. Dahlgren,[2] United States Navy, Pennsylvania; J. D. Dana, Connecticut; Charles H. Davis, United States Navy, Massachusetts; George Engelmann, Saint Louis, Missouri; J. F. Frazer, Pennsylvania; Wolcott Gibbs, New York; J. M. Gilless,[3] United States Navy, District of Columbia; A. A. Gould, Massachusetts; B. A. Gould, Massachusetts; Asa Gray, Massachusetts; A. Guyot, New Jersey; James Hall, New York; Joseph Henry, at large; J. E. Hilgard, at large, Illinois; Edward Hitchcock, Massachusetts; J. S. Hubbard, United States Naval Observatory, Connecticut; A. A. Humphreys, United States Army, Pennsylvania; J. L. Le Conte, United States Army, Pennsylvania; J. Leidy, Pennsylvania; J. P. Lesley, Pennsylvania; M. F. Longstreth, Pennsylvania; D. H. Mahan, United States Military Academy, Virginia; J. S. Newberry, Ohio; H. A. Newton, Connecticut; Benjamin Peirce, Massachusetts; John Rodgers, United States Navy, Indiana; Fairman Rogers, Pennsylvania; R. E. Rogers, Pennsylvania; W. B. Rogers, Massachusetts; L. M. Rutherford, New York; Joseph Saxton, at large; Benjamin Silliman, Connecticut; Benjamin Silliman, junior, Connecticut; Theodore Strong, New Jersey; John Torrey, New York; J. G. Totten, United States Army, Connecticut; Joseph Winlock, United States Nautical Almanac, Kentucky; Jeffries Wyman, Massachusetts; J. D. Whitney, California; their associates and successors duly chosen, are hereby incorporated, constituted, and declared to be a body corporate, by the name of the National Academy of Sciences.

SEC. 2. *And be it further enacted*, That the National Academy of Sciences shall consist of not more than fifty ordinary members, and

[1] The official list of members gives the name of F. A. P. Barnard.
[2] Declined.
[3] The official list of members gives the name of J. M. Gillis.

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the said corporation hereby constituted shall have power to make its own organization, including its constitution, by-laws, and rules and regulations; to fill all vacancies created by death, resignation, or otherwise; to provide for the election of foreign and domestic members, the division into classes, and all other matters needful or usual in such institution, and to report the same to Congress.

SEC. 3. *And be it further enacted*, That the National Academy of Sciences shall hold an annual meeting at such place in the United States as may be designated, and the academy shall, whenever called upon by any department of the Government, investigate, examine, experiment, and report upon any subject of science or art, the actual expense of such investigations, examinations, experiments, and reports to be paid from appropriations which may be made for the purpose, but the academy shall receive no compensation whatever for any services to the Government of the United States.

Approved, March 3, 1863.

AMENDMENTS.

AN ACT To amend the act to incorporate the National Academy of Sciences.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the act to incorporate the National Academy of Sciences, approved March third, eighteen hundred and sixty-three, be, and the same is hereby, so amended as to remove the limitation of the number of ordinary members of said academy as provided in said act.

Approved, July 14, 1870.

AN ACT To authorize the National Academy of Sciences to receive and hold trust funds for the promotion of science, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the National Academy of Sciences, incorporated by the act of Congress, approved March third, eighteen hundred and sixty-three, and its several supplements, be, and the same is hereby, authorized and empowered to receive bequests and donations and hold the same in trust, to be applied by the said academy in aid of scientific investigations and according to the will of the donors.

Approved, June 20, 1884.

AN ACT To amend the act authorizing the National Academy of Sciences to receive and hold trust funds for the promotion of science, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the act to authorize the National Academy of Sciences to receive and hold

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trust funds for the promotion of science, and for other purposes, approved June twentieth, eighteen hundred and eighty-four, be, and the same is hereby, amended to read as follows:

"That the National Academy of Sciences, incorporated by the act of Congress approved March third, eighteen hundred and sixty-three, be, and the same is hereby, authorized and empowered to receive, by devise, bequest, donation, or otherwise, either real or personal property, and to hold the same absolutely or in trust, and to invest, reinvest, and manage the same in accordance with the provisions of its constitution, and to apply said property and the income arising therefrom to the objects of its creation and according to the instructions of the donors: *Provided, however*, That the Congress may at any time limit the amount of real estate which may be acquired and the length of time the same may be held by said National Academy of Sciences."

SEC. 2. That the right to alter, amend, or repeal this act is hereby expressly reserved.

Approved, May 27, 1914.

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ANNUAL REPORT

OF THE

NATIONAL ACADEMY OF SCIENCES.

MEETINGS OF THE NATIONAL ACADEMY.

During the year 1917 the academy held two stated meetings, the annual meeting in April, at Washington, and the autumn meeting in November, at Philadelphia, Pa.

ANNUAL MEETING.

The sessions were held at the Smithsonian Institution in Washington, April 16, 17, and 18, 1917.

Seventy-six members were present, as follows:

Abbot, C. G.
Abel, John Jacob
Barnard, E. E.
Becker, George F.
Bogert, M. T.
Cannon, W. B.
Cattell, James McK.
Chittenden, R. H.
Clark, W. B.
Clarke, F. W.
Clarke, J. M.
Conklin, E. G.
Coulter, J. M.
Crew, Henry
Cross, Whitman
Dall, William H.
Dana, Edward S.
Davenport, Charles B.
Davis, W. M.
Day, Arthur L.
Dewey, John
Donaldson, H. H.
Fewkes, J. W.
Flexner, Simon
Frost, Edwin B.
Gomberg, Moses
Hague, Arnold
Hale, George E.
Hall, Edwin H.
Harper, R. A.
Hayford, John F.
Hillebrand, William F.
Holmes, William H.
Howard, L. O.
Howell, W. H.
Iddings, J. P.
Jennings, H. S.
Lillie, F. R.
Loeb, Jacques
Lusk, Graham
Mall, Franklin P.
Meltzer, S. J.
Merriam, C. Hart
Merritt, Ernest
Michelson, A. A.
Millikan, R. A.
Moore, E. H.
Morley, E. W.
Nichols, Edward L.
Nichols, Ernest F.
Noyes, Arthur A.
Noyes, William A.
Osborn, H. F.
Pearl, Raymond

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Pickering, E. C.
Pupin, Michael I.
Ransome, F. L.
Remsen, Ira.
Rosa, Edward B.
Schlesinger, Frank
Scott, William B.
Smith, Erwin F.
Stieglitz, Julius
Van Vleck, E. B.
Vaughan, Victor Clarence
Walcott, Charles D.
Webster, A. G.
Welch, William H.
Wheeler, William M.
White, David
White, Henry Seely
Wilson, Edmund B.
Wood, Robert W.

BUSINESS SESSIONS.

ANNOUNCEMENTS OF DEATHS.

The president announced the death since the autumn meeting of one foreign associate, Gaston Darboux.

The annual report of the president to Congress for 1916 was presented and distributed.

The president announced the appointment of the following committees:

LOCAL COMMITTEE.

Charles G. Abbot, chairman.

Charles D. Walcott.
William H. Dall.
William F. Hillebrand.
Whitman Cross.

FINANCE COMMITTEE FOR THE PROCEEDINGS.

C. B. Davenport, chairman.

M. T. Bogert.
W. B. Clark.
F. R. Lillie.
Raymond Pearl.

DELEGATE.

Mr. William Trelease was selected to represent the academy at the inauguration of Walter Albert Jessup as president of Iowa State University.

REPORT OF THE HOME SECRETARY.

The PRESIDENT OF THE NATIONAL ACADEMY OF SCIENCES.

SIR: I have the honor to present the following report on the publications and membership of the National Academy of Sciences for the year ending April 18, 1917. The memoirs of the National Academy of Sciences, volume 14, memoir 1, entitled, "Report on Researches on the Chemical and Mineralogical Composition of Meteorites, with Especial Reference to their Minor Constituents," by George Perkins Merrill, was published and distributed. The biographical memoirs of Edward Singleton Holden, by W. W. Campbell; Theodore Nicholas Gill, by William Healey Dall; George William Hill, by Ernest W. Brown; and Alfred Marshall Mayer, by Alfred G. Mayer and Robert S. Woodward; also the annual report, 1916, have been published and distributed.

Two members have died since the last annual meeting. Cleveland Abbe, elected in 1878, died October 28, 1916; Josiah Royce, elected in 1906, died

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September 14, 1916. Foreign associates: Sir William Ramsey, elected 1904, died July 24, 1916, and Gaston Darboux, elected in 1913, died March, 1917. There are 147 active members on the membership list, 1 honorary member, and 37 foreign associates.

ARTHUR L. DAY, *Home Secretary.*

REPORT OF THE FOREIGN SECRETARY.

On April 6, 1917, a cablegram was prepared by Mr. Hale, foreign secretary of the academy, with the approval of the following members of the council: Welch, Walcott, Day, Cross, and Hale.

"The entrance of the United States into the war unites our men of science with yours in a common cause. The National Academy of Sciences, acting through the National Research Council, which has been designated by President Wilson and the Council of National Defense to mobilize the research facilities of the country, would gladly cooperate in any scientific researches still underlying the solution of military or industrial problems.

"HALE, *Foreign Secretary.*"

The cablegram was sent to Royal Society, London, England; Académie des Sciences, Paris, France; Accademia dei Lincei, Rome, Italy; Académie des Sciences, Petrograd, Russia.

GEORGE E. HALE, *Foreign Secretary.*

REPORT OF THE TREASURER.

The report of the treasurer was presented in its printed form and approved.

REPORT OF THE DIRECTORS OF THE BACHE FUND.

Since the annual meeting of the academy in April, 1916, the following grants have been made:

No. 196. Harry W. Norris, Grinnell College, Iowa, $100. For an investigation of the cranial nerve of the amphibia.

No. 197. Gregory P. Baxter, Harvard University, $300. For the determination of atomic weights of arsenic and iodine by iodimetric comparison of arsenic trioxide and iodine pentoxide, and of various metals by electrolysis of weighed amounts of salts, and by coulometric comparison.

No. 198. Louis T. More, University of Cincinnati, $500. For apparatus to be used in examining the region of the radiation spectrum between the hardest known X rays and the lambda rays of radium, and to examine the characteristic K radiation and its absorption by various metals.

No. 199. Frnklin P. Reagan, Woods Hole, $100. For an intensive study of hæmatopoisis is teleost embryos involving continual observation.

No. 200. H. W. Norris, Grinnell College, Iowa, $250. For an investigation of the cranial nerve components of the common dogfish, squales, acanthias; and analysis of the cranial ganglia and the peripheral distribution of the component fibers.

No. 201. A. Franklin Shull, University of Michigan, $400. To discover the causes of the changes in the life cycles of rotifers, aphids, and thrips, with special reference to the determination of sex; also related cyclical phenomena in the aphids, primarily the sporadic production of wings.

No. 202. W. C. Allee, Lake Forest College, Ill., $415. For an investigation of a possible correlation between the rate of carbon dioxide production and reversal in light reactions of certain Arthropods, especially May-fly nymphs.

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No. 203. Joseph P. Iddings, Brinklow, Md., $500. For a continuance of the microscopical and chemical investigation of rocks collected by Mr. Iddings in Japan, Philippine Islands, Java, Borneo, Celebes, Sumatra, New Zealand, Tahiti, the Leeward Islands, and the Marquesas.

No. 204. Irving W. Bailey, Bussey Institution, Harvard University, $300 To secure field data in regard to the effects of various tropical environments upon the growth forms of the angiosperms and to secure material for a study of the effects of these environments upon the anatomical structure of the angiosperms. (Expedition to Guatemala has been delayed.)

Reports of previous grants have been received as follows:

No. 186. J. Voûte, Royal Observatory, Cape of Good Hope. From a letter dated January 15, 1915, it appears that about 13,000 transits had then been observed for the purpose of determining stellar parallaxes. From a letter dated July 22, 1916: "The parallax work on the transit circle is nearly finished, but I have started a small series of about 125 stars on the astrographic refractor."

No. 187. H. H. Lane, University of Oklahoma. Preliminary report on "The structure and function in the development of the special senses in mammals." Science, 43, 179 (1916).

Nos. 188 and 196. H. W. Norris, Grinnell College. Research nearly ready for publication. Preliminary results on the cranial nerve of coecilians published in Science, 43, 182 (1916).

No. 189. E. J. Werber, Yale University. Experiments aiming at the origin of monsters. The greater part of the results are published in the Journal of Experimental Zoology, 21, Nos. 3 and 4 (1916). Record of award closed.

No. 190. H. S. Jennings, Johns Hopkins University. For research in variation, heredity, and evolution. Preliminary results published in Genetics, 1, 407–534 (1916?).

Nos. 184 and 191. P. W. Bridgman, Harvard University. To assist in the study of the effect of high pressures on the electrical resistance of metals. The results have been published in Proceedings of the National Academy of Sciences, 3, 10–12, 1917; Proceedings of the American Academy, 52, 571–646 (1917); and in a theoretical article soon to appear in the Physical Review. Record of award closed.

No. 192. J. P. Iddings, Brinklow, Md. For a microscopic study of volcanic rocks from the Dutch Indies, French Oceania, and the Philippines. Preliminary results are published in Proceedings of the National Academy of Sciences, 2, 531 (1916). Research being continued under grant 203.

No. 194. Reginald A. Daly, Harvard University. For the construction of a deep-sea thermograph. The vital part of the instrument is practically ready for testing, and it is hoped that the whole will be ready for work by May 1. The clockwork has been tested and shows capacity for taking 250 readings with one cast of the machine overboard. The manuscript descriptive of the instrument, by Dr. Harry Clark, the expert designer, to be illustrated with several full-page plates, is nearly completed. The necessary expenditure has considerably exceeded the appropriation.

No. 195. R. W. Hegner, University of Michigan. To assist a research of "Differential mitoses in the germ cell cycle of dineutes nigrior." Preliminary publication in Proceeding of the National Academy of Sciences, 2, 356–360, 1916.

No. 197. Gregory P. Baxter, Harvard University. The preparation of pure anhydrous zinc chloride and its analysis by electrolysis are under way and will probably be completed before the end of the college year.

No. 198. Louis T. More, University of Cincinnati. Preliminary results are published in the Physical Review, 9, 198–204, 1917, by J. S. Allen and L. M.

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Alexander, "On the effect of previous filtering upon the absorption of high frequency X rays." The research continues.

No. 199. Franklin P. Reagan, Princeton University. The partial results are published in the Anatomical Record, February, 1917, under the title "Anterior hæmatopœdis in teleost embryos under continual observation," by F. P. Reagan, E. E. MacMorland, and Stuart Mudd.

During the year the directors unanimously voted to cancel the rule heretofore effective for grants from the Bache fund, which stated "no appropriation will be made to assist any investigation begun or conducted under any National or State government, either wholly or in part."

The cash income balance of the fund on April 2, 1917, was $846.30; but there are outstanding grants, not yet paid, amounting to $2,050. Of three of these grants, amounting to $1,600, the recipients of which live in foreign countries, it seems to be impossible to make payments until the end of the war.

EDWIN B. FROST, *Chairman.*

REPORT OF THE TRUSTEES OF THE WATSON FUND.

The trustees of the Watson fund advise the academy that during the year the grant of $500 voted at the annual meeting for 1916 has been paid to Prof. John A. Miller, director of the Sproul Observatory of Swarthmore College, Pa., whose report may be condensed as follows:

"The money has been paid to an assistant, Miss Marie S. Bender, who has given all her energy to the measurement and reduction of plates for determining parallaxes. She has measured 130 plates of 24 different series and has computed the orientation factor and oriented 122 plates and has discussed eight different series by means of graphs. The continuance of the grant is requested."

A grant of $300 was made in April, 1916, to Prof. Herbert C. Wilson, of Carleton College, Northfield, Minn., who says in a letter dated April 7, 1917:

"We have measured all of our asteroid plates up to the beginning of this year, and all have been reduced. We are now going over the reductions thoroughly, checking them. * * * It will be a couple of months yet before we can get the matter ready for the press."

The grant of $300, made in 1915 to John E. Mellish, was used in 1915–16, and its record may be considered closed.

The following vote is recommended:

GRANT NO. 13.

Resolved, That the appropriation of $500 to Prof. John A. Miller be renewed for the year beginning July 1, 1917.

GRANT NO. 14.

Resolved, That $325 be appropriated for a continuance of the work conducted by Prof. Herbert C. Wilson, consisting of the determination of the position and brightness of asteroids (chiefly those discovered by Watson) by the photographic method, together with a study of the brightness of some variable stars.

The available income of the Watson fund on April 1, 1917, was $1,213.65.

EDWIN B. FROST, *Chairman.*
W. L. ELKINS.
G. C. COMSTOCK.

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REPORT OF THE COMMITTEE ON THE HENRY DRAPER FUND.

The committee recommends that a grant of $300 be made to Prof. Joel Stebbins, director of the observatory of the University of Illinois, in support of his investigations with sensitive photometers, particularly the photo-electric cell photometer; the grant to be available on or before September 1, 1917. It is understood that this grant will be supplemented by the appropriation of a sum two or three times as great to be made by the University of Illinois, and that the total sum will constitute the salary of a research assistant for Prof. Stebbins during the academic year 1917–18. It is expected that all of the assistant's time in the first year will be available for the researches in photometry, and that after the first year the university authorities will assume the full responsibility for the assistant's salary. Prof. Stebbins reports that improvements have been made in his photo-electric photometer. "A new quartz cell as compared with the cell used at Mount Hamilton (1915) gives twice the light effect, with the dark current five times smaller. It is therefore conservative to say that the sensibility has been doubled since 1915."

W. W. CAMPBELL, *Chairman.*

APRIL 2, 1917.

REPORT OF THE COMMITTEE ON THE J. LAWRENCE SMITH FUND.

Grant No. 3. E. O. Hovey, curator in geology and paleontology, American Museum of Natural History, New York, received in 1910 a grant of $400 to aid in the study of certain meteorites. Dr. Hovey has been for some years out of the country and has not been reached by letters. He has suggested the repayment of the amount of this grant.

Grant No. 4. Prof. C. C. Trowbridge, of the department of physics, Columbia University, New York, received a grant of $400 in 1910 to aid in study of luminous trains of meteors, and the academy has made four further grants of $250 each. During the last year good progress has been made in collecting photographs of drawings of meteor trains. One interesting result obtained is that the height of the zone of luminous trains agrees with the heights obtained in recent investigations on the auroral zone and is suggestive.

Grant No. 6. Prof. S. A. Mitchell, of the University of Virginia, received a grant of $500 in 1915 and a further grant of $300 in 1916 to aid in securing observations of paths and radiants of meteors and in computing orbits where observations are sufficient. Good progress has been made in the work; and the committee are unanimous in recommending a further grant of $400.

Grant No. 7. Dr. George P. Merrill, of the United States National Museum, received last November a grant of $400 to aid in further studies of the occurrence of certain elements in meteorites, for which he had formerly received grant No. 5, on which he had made his final report. This work is in progress.

The uninvested income now available for grants is $677.13.

EDWARD W. MORLEY, *Chairman.*

REPORT OF THE DIRECTORS OF THE WOLCOTT GIBBS FUND.

The directors of the Wolcott Gibbs fund for chemical research have the honor of presenting the following report to the National Academy of Sciences:

The accumulated income of the fund amounted to $356.11 on March 1, 1917. Since that date a grant of $200, No. 7, has been made to Prof. W. D. Harkins, of the University of Chicago, for the purchase of an air pump, which will be of use in five researches either now in progress or to be undertaken in the near future.

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Also a grant, No. 8, of £25 to Prof. H. L. Datta, of Presidency College, Calcutta, India, to provide organic substances for his researches of chlorination.

Satisfactory reports have been received from holders of previous grants.

Grants 1 and 5. Prof. Mary E. Holmes reports that her paper on the electrical deposition of copper is nearly ready for publication and that she has studied the electrical separation of cadmium from eight other metals.

Grant 3. Prof. W. J. Hale has published the results of his work under this grant in a paper on "The formation of cyclopentadienodihydropyridazines," Journal American Chemical Society, 1916, pages 2537 to 2545, thus bringing the record of this grant to a successful end.

Grant 4. Prof. W. D. Harkins sends copies of three papers describing work done under this grant. (*a*) "The free energy of dilution and the freezing-point lowerings in solutions of some salts of various types of ionization and of salt mixtures." Harkins and R. E. Hall, Journal American Chemical Society, 38, pages 2658 to 2676. (*b*) "The freezing-point lowerings in aqueous solutions of salts and mixtures of salts and of a salt with a nonelectrolyte." Harkins and W. A. Roberts, Journal American Chemical Society, 38, pages 2676 to 2679. (*c*) "Studies on the Cobalt-ammines. I. Various ionization types as determined by the freezing-point lowerings in aqueous solution, together with conductance measurements." Harkins, Hall, and Roberts, Journal American Chemical Society, 38, pages 2643 to 2658.

Grant 6. Prof. G. P. Baxter reports that he has studied with the help of the grant: (*a*) Sources of error in the electrolytic determination of the atomic weight of cadmium, and analysis of cadmic sulphate; (*b*) gaseous impurities of silver and iodine; (*c*) relation between arsenious trioxide and iodine.

Each of these researches should be finished in a few months.

C. L. JACKSON, *Chairman.*
EDGAR F. SMITH.
THEODORE W. RICHARDS.

REPORT OF THE COMMITTEE ON THE MURRAY FUND.

The committee on the Murray fund has no recommendation to report this year. The conditions in Europe and the North Atlantic have precluded oceanographic work entirely, and consequently nothing in the way of progress can be reported. The statement of the treasurer of the academy showing the condition of the fund is appended.

WILLIAM H. DALL, *Chairman.*

The treasurer reports a cash income balance on the Murray fund of $274.97.

REPORT OF THE COMMITTEE ON BIOGRAPHICAL MEMOIRS.

The committee on biographical memoirs respectfully reports that a circular letter has been sent to each biographer asking for information concerning the progress of the memoir he has in charge. Responses to this inquiry revealed a few cases in which the assigned biographer was ignorant of his assignment, and others in which conditions made necessary a reassignment. The biography of William Stimpson has been prepared for the press by A. G. Mayer; that of F. A. P. Barnard is promised by C. F. Chandler in about three weeks.

Biographies of all members who died more than 15 years ago are thus accounted for.

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A circular letter was sent to all members in December suggesting that each prepare at the end of each year an autobiographical record for the preceding year. A number of members have utilized this suggestion and a number have deposited biographical material with the committee.

C. B. DAVENPORT, *Chairman.*
G. C. COMSTOCK.
A. G. MAYER.
A. L. DAY.

DANIEL GIRAUD ELLIOT FUND.

The council reported the acceptance for the academy of the gift of $8,000, made to the National Academy of Sciences by Miss Margaret Henderson Elliot in pursuance of her desire to carry out a testamentary provision in the will of her father, Daniel Giraud Elliot, which would have been operative under circumstances stated in the will and applied in accordance with the terms of the legacy as fully set forth in the will whereby a medal, to be known as the Daniel Giraud Elliot gold medal, together with an accompanying diploma and an unexpended balance of income for the year, was to be awarded annually to the author of such paper, essay, or other work upon some branch of zoology or paleontology published during the year as in the opinion of the judges, who shall be Henry Fairfield Osborn, of New York, the scientific director of the American Museum of Natural History, and the secretary of the Smithsonian Institution, shall be the most meritorious and worthy of honor.

RESIGNATION OF PRESIDENT WELCH.

Mr. William H. Welch presented the following letter, resigning the presidency of the academy, to take effect with the close of the present meeting, which was accepted with great regret:

NATIONAL ACADEMY OF SCIENCES,
April 16, 1917.

TO the MEMBERS OF THE NATIONAL ACADEMY OF SCIENCES:

GENTLEMEN: In accordance with the intention which I announced at our semi-annual meeting last November, I hereby tender my resignation of the office of president of the academy, to take effect at the close of the present annual meeting.

It is mainly the assumption of new and exacting duties and responsibilities connected with the organization and development of the School of Hygiene and Public Health recently established at the Johns Hopkins University which leads me to withdraw from a position which should receive much of the time and thought and energy of the incumbent.

It is a source of gratification that the academy, while retaining its distinguished position as representative of those most eminent for their contributions to science in America, has widened in recent years its field of activities and thereby become more useful and significant in the advancement of science in our country. It is to be hoped and expected that the academy in its activities, influence, and membership will be still further broadened and become

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increasingly serviceable and important in the promotion of knowledge and of the welfare of the Nation.

I wish to renew the expression of my profound appreciation of the very high honor which was conferred upon me four years ago by election to the presidency of the academy, as well as my appreciation of the continued loyalty and support and kindness of the members. I desire likewise to record my gratitude and indebtedness for the unfailing aid of the officers of the academy, and especially of the home secretary and the foreign secretary, who have really carried the burden of the conduct of affairs.

Faithfully, yours,

WILLIAM H. WELCH.

AUTUMN MEETING.

The invitation of the provost and trustees of the University of Pennsylvania to hold the autumn meeting in Philadelphia was accepted.

ELECTION OF OFFICERS AND MEMBERS.

President: Mr. Charles Doolittle Walcott was unanimously elected president for a term of six years to expire in 1923.

Vice president: Mr. A. A. Michelson was unanimously elected vice president for a term of six years to expire in 1923.

Treasurer: Mr. Whitman Cross was unanimously elected to succeed himself for a term of six years to expire in 1923.

Two members of the council: Mr. A. A. Noyes and Mr. E. G. Conklin were elected to succeed themselves for terms of three years each to expire in 1920.

The following members were elected:

Walter Sydney Adams, astronomer, Mount Wilson Solar Observatory of the Carnegie Institution of Washington, Pasadena, Cal.

Liberty Hyde Bailey, horticulturist, Ithaca, N. Y.

John J. Carty, electrical engineer, American Telegraph & Telephone Co., New York, N. Y.

Harvey Cushing, surgeon, Harvard University, Cambridge, Mass.

William Frederick Durand, mechanical engineer, Leland Stanford Junior University, Stanford University, Cal.

William Stewart Halsted, surgeon, Johns Hopkins Medical School. Baltimore, Md.

Henry Marion Howe, metallurgist, professor emeritus, Columbia University, New York, N. Y.

Edward Kasner, mathematician, Columbia University, New York, N. Y.

Theodore Lyman, physicist, Harvard University, Cambridge, Mass.

Robert Ridgway, ornithologist, United States National Museum, Washington, D. C.

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Wallace C. Sabine, physicist, Harvard University, Cambridge, Mass.

Samuel Wesley Stratton, physicist, Bureau of Standards, Washington, D. C.

Edward Lee Thorndike, psychologist, Columbia University, New York, N. Y.

Edward Oscar Ulrich, paleontologist, United States Geological Survey, Washington, D. C.

Willis Rodney Whitney, chemist, General Electric Co., Schenectady, N. Y.

SECTION AND COMMITTEE ANNOUNCEMENTS.

Section of astronomy: W. W. Campbell, chairman, 1920.

Program: C. G. Abbot, chairman, 1918; Raymond Pearl, 1920.

Henry Draper fund: A. A. Michelson, to succeed himself, 1922.

J. Lawrence Smith fund: Whitman Cross, 1922.

Comstock fund: A. G. Webster, to succeed himself, 1922.

Marsh fund: E. S. Dana, to succeed himself, 1920.

Murray fund: G. H. Parker, to succeed himself, 1920.

Marcellus Hartley fund: Theobald Smith, to succeed himself, 1920; A. G. Webster, to succeed himself, 1920.

On publication: E. B. Rosa.

TRUSTEES OF THE WATSON FUND.

The home secretary presented the following communication from Mr. Edwin B. Frost, resigning as a member of the trustees of the Watson fund:

APRIL 12, 1917.

DEAR MR. DAY: Please present to the council my resignation as a member of the trustees of the Watson fund. It is necessary for me to give up further service on this committee, but I am willing to continue as chairman of the Bache committee for another year.

Very truly, yours, EDWIN B. FROST.

The resignation of Mr. Frost was accepted and Mr. A. O. Leuschner was elected chairman of the trustees of the Watson fund.

INTERNATIONAL ACADEMIES.

The foreign secretary presented the following communication from the Académie des Sciences at Paris, received through the ambassador from France to the United States:

AMBASSADE,
DE LA REPUBLIQUE FRANCAISE,
AUX ETATS-UNIS,
Washington le April 16, 1917.

MY DEAR MR. SECRETARY: I am informed by my Government that our "Académie des Sciences" has received from the "National Academy of Sciences" a friendly telegram by which they have been deeply touched.

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I am instructed to forward to you their answer, the text of which is here inclosed. I have the honor to be, dear Mr. Secretary,

Sincerely, yours,

JUSSERAND.

Mr. HALE,
Foreign Secretary National Academy of Sciences,
Washington, D. C.

PARIS, *18 avril, 1917.*

NATIONAL ACADEMY OF SCIENCES,
Washington, D. C.:

L'Académie des Sciences de l'Institut de France est heureuse de saluer l'aide que votre noble pays apporte au nôtre, et à ses alliés dans leur lutte pour le droit et la liberté.

Elle vous remercie de votre offre, et sera heureuse de collaborer avec l'Académie Nationale des Sciences pour la solution des problèmes scientifiques intéressant la defénse nationale et l'industrie.

A. LACROIX,
EMILE PICARD,
Secrétaires Perpétuels.

The foreign secretary presented the following communication from the Royal Society, London, received through the ambassador from Great Britain to the United States:

Dr. GEORGE E. HALE,
Washington, D. C.:

The Royal Society heartily welcomes the offer of the National Academy to cooperate in scientific researches connected with the war, and will communicate by letter proposals for carrying this into effect.

THOMSON, *President.*

PLATINUM.

The following resolutions were adopted:

Whereas there is a great shortage in the supplies of platinum available for scientific and industrial purposes; and

Whereas the shortage is in very great measure due to the extensive use of platinum for jewelry and other articles of luxury: Therefore, be it

Resolved, That the National Academy of Sciences, in this critical situation where all the resources of the Nation should be put to the use of those immediately active in the constructive, productive, and defensive work of the country, appeal to the women and the men of America to refuse to purchase or accept as gifts jewelry and other articles made in whole or in part of platinum and thus to allow all the available supplies of the meral to be used where they can do the greatest good.

AWARD OF MEDALS.

The following medals were awarded at the annual dinner on the evening of April 17, 1917, at the Raleigh Hotel:

The Henry Draper Medal, to A. A. Michelson, of the University of Chicago, for his numerous and important contributions to spectroscopy and astronomical physics.

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The Medal for Eminence in the Application of Science to the Public Welfare, to Samuel Wesley Stratton, for his services in introducing standards into the practice of technologists in the United States.

SCIENTIFIC SESSIONS.

MEETING OF APRIL 16–18, 1917.

MONDAY, APRIL 16.

MORNING SESSION.

J. P. Iddings and E. W. Morley: Report of progress in the study of igneous rocks from the East Indies and Islands of the South Pacific.

W. M. Davis: The Great Barrier Reef of Queensland, Australia (illustrated).

Charles D. Walcott: Searching for a doubtful geological zone in the Canadian Rockies (illustrated).

Arthur L. Day: The role of the gases in volcanic activity (illustrated).

W. A. Noyes: A kinetic hypothesis to explain the function of electrons in the chemical combination of atoms.

A. A. Michelson (Draper Medalist, 1917): Some recent work in physics.

W. B. Cannon: Some considerations regarding the nature of thirst.

AFTERNOON SESSION.

Erwin F. Smith: On resemblances of crown gall to cancer: A synopsis of work done in the United States Department of Agriculture.

R. J. Anderson and Graham Lusk: The influence of diet upon the heat production during mechanical work in the dog.

Jacques Loeb and J. H. Northrop: What determines the natural duration of life?

A. G. Mayer: Biographical memoir of William Stimpson. (By title.)

Benjamin Boss: Biographical memoir of Lewis Boss. (By title.)

First William Ellery Hale lecture, by Edwin Grant Conklin, professor of zoology, Princeton University. Subject: Methods and causes of organic evolution.

TUESDAY, APRIL 17.

MORNING SESSION.

Simon Flexner: Mechanisms that defend the body from poliomyelitic infection, (*a*) external or extranervous, (*b*) internal or nervous.

T. S. Githens and S. J. Meltzer: The difference in the action of antipyretics according to the species of animals subjected to this action, the state of health of the animals, the height of their normal temperature and the substance employed.

Charles B. Davenport: Heredity and juvenile promise of eminent naval men.

Henry Fairfield Osborn: The causes of the evolution of proportions by mammals.

W. V. King (introduced by L. O. Howard): Sporogony of malaria parasites. Photomicrographs of infected anopheles.

Frank R. Lillie: Sex determinations and sex differentiation in mammals.

Herbert J. Spenden (introduced by W. H. Holmes): Economic contributions of ancient America.

Sylvanus G. Morley (introduced by J. W. Fewkes): The Maya hieroglyphic writing.

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E. E. Barnard: The star in Ophiuchus with great proper motion.

E. E. Barnard: Total lunar eclipse of January 7, 1917.

E. E. Barnard: Measures of the position of the nucleus of the great nebula of Andromeda.

Edwin B. Frost: Recent remarkable changes in a nebula.

AFTERNOON SESSION.

The work of the National Research Council: George E. Hale, chairman National Research Council; Charles D. Walcott, chairman military committee; Robert Andrews Milliken, chairman physics committee; Marston Taylor Bogert, chairman chemistry committee; Victor Clarence Vaughan, chairman committee on medicine and hygiene.

WEDNESDAY, APRIL 18.

Second William Ellery Hale lecture, by Edwin Grant Conklin, professor of zoology, Princeton University. Subject, Methods and causes of organic evolution.

AUTUMN MEETING.

The autumn meeting of the academy was held in the Engineering Building of the University of Pennsylvania at Philadelphia, on November 20 and 21, 1917.

Fifty-six members were present, as follows:

Abbot, C. G.
Bailey, L. H.
Bogert, M. T.
Carty, J. J.
Clarke, F. W.
Clarke, J. M.
Conklin, E. G.
Coulter, J. M.
Cross, Whitman
Davenport, Charles B.
Day, Arthur L.
Donaldson, H. H.
Farlow, W. G.
Flexner, Simon
Hale, George E.
Hall, E. H.
Halsted, William Stewart
Harper, R. A.
Harrison, Ross G.
Holmes, William H.
Howard, L. O.
Howe, H. M.
Howell, W. H.
Iddings, J. P.
Jennings, H. S.
Kasner, Edward
Leuschner, Armin O.
Levene, P. A. T.
Loeb, Jacques
Lusk, Graham
Mayer, A. G.
Meltzer, S. J.
Mendel, Lafayette B.
Millikan, R. A.
Morgan, T. H.
Morse, E. S.
Nichols, E. L.
Noyes, A. A.
Osborn, H. F.
Pearl, Raymond
Pupin, Michael I.
Reid, H. Fielding
Schlesinger, Frank
Scott, William B.
Smith, Alexander
Smith, Edgar F.
Smith, Erwin F.
Stratton, Samuel Wesley
Thomson, Elihu
Thorndike, Edward L.
Walcott, Charles D.
Welch, William H.
Wheeler, William M.
White, David
White, H. S.
Wilson, Edmund B.

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BUSINESS SESSIONS.

ANNOUNCEMENT OF DEATHS.

The president announced the following deaths since the last annual meeting of the academy:

Arnold Hague, elected 1885, died May 15, 1917.
J. M. Crafts, elected 1872, died June 21, 1917.
William B. Clark, elected 1908, died July 27, 1917.
Franklin P. Mall, elected 1907, died November 17, 1917.
Adolf von Baeyer, foreign associate, elected 1898, died August, 1917.

BIOGRAPHICAL MEMOIRS.

The president also announced the assignment of the following biographical memoirs: Arnold Hague, to J. P. Iddings; William Bullock Clark, to John M. Clarke; and Franklin P. Mall, to R. G. Harrison.

EDITORIAL BOARD.

Under the rules of the academy the following members of the editorial board of the Proceedings retire December 1, 1917: E. G. Conklin, C. B. Davenport, E. B. Frost, W. H. Holmes, and E. H. Moore. The home secretary announced that the following members had been appointed by the council to serve in their places until December 1, 1920: Jacques Loeb, W. M. Wheeler, E. B. Frost, E. L. Thorndike, and E. H. Moore. E. B. Wilson was reappointed managing editor for one year.

SECTION AND COMMITTEE ANNOUNCEMENTS.

Section of Anthropology and Psychology: J. Walter Fewkes, to succeed J. McKeen Cabbell.

Program committee: Edward L. Thorndike, to succeed J. McKeen Cabbell.

REPORT OF THE EDITORIAL BOARD.

As we have now completed the third volume of our Proceedings it seems to me opportune to circulate some statistics relative to the Proceedings and covering its whole existence. You will notice in the summary of articles according to subjects that mathematics and astronomy have recently dropped off a little, although their totals remain satisfactory. Physics has come to a satisfactory total, mainly by the large number of articles last year. Chemistry, considering the amount of chemical work in this country relative to work in other lines, has not a satisfactory total, nor has the number of articles been satisfactory in either of the last two years. Two of the articles in 1915 in chemistry might have been called agriculture. It has seemed best to introduce agriculture as a special topic, although it is clear that the make-up of the academy is such that we can hardly expect a very large number of articles in agriculture, except on general grounds. Geology, though having a bad start, has satisfactory totals, and the same is true of zoology and genetics. Botany, however, has always been low, perhaps because of a relatively smaller output in botany in this country. Physiology and pathology seem to me hardly satisfactory in their totals, pathology in particular having very few articles in comparison with the great activity in that subject in this country. Anthropology

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has perhaps been particularly hard hit by the war, and psychology has always been small in the Proceedings, possibly because there is not a proportionate degree of activity in scientific psychology in this country.

I should be glad if this summary may be of some help to the editors in pointing out those branches in which special effort should be made to have the Proceedings properly representative of American research. The war period is one in which research will probably suffer seriously, and for that reason is a period in which more than ordinary discrimination and effort must be used to keep the Proceedings up to standard and truly representative. The action of this board in voting that the size of the Proceedings should not be materially diminished is an indication that the board feels that particularly during the war period the Proceedings should be kept up. Indeed, if the Proceedings is carefully and conscientiously maintained in standard and size during the period of the war, it would almost seem as though no efforts after the war would be necessary other than those of eliminating superabundant material and thus automatically raising the standard.

You will see from the summary of institutions which have contributed more than three articles that there has been a great diminution in receipts from the University of Chicago, University of California, Johns Hopkins University, and the Rockefeller Institute. As the number of articles has not varied greatly from year to year, this diminution has been made up in the main by straggling articles from all sorts of places. The Proceedings certainly should welcome this increase in the distribution of its articles. It shows for one thing that the Proceedings is becoming representative of American research. It does seem, however, as though the number of articles received from the University of Chicago, University of California (including the Lick Observatory), and from the Rockefeller Institute are disproportionately small this year, and it may be feared that unless these leading institutions do better in the future we must infer that while the Proceedings is growing in representative character the country over, it is losing sadly in obtaining the best work of the best men in the best institutions and is thus in one way becoming far less representative than it should be.

The statistics of articles by members of the academy as compared with articles by nonmembers are interesting mainly in showing a progressive diminution in the percentage of articles by members, despite the increase in membership of the academy. If there are obstacles which can be removed and which hinder members of the academy from printing in the Proceedings, would it not be well to make efforts to remove them? The academy represents the highest point in American research, and if the Proceedings should actually contain articles representing the totality of the investigations of members of the academy it would thereby become largely representative of all American research and of very high grade, and furthermore it would be more truly the Proceedings of the academy in the sense that corresponding publications of foreign academies are representative of their research.

The average length of articles has varied very little and is satisfactory.

The vote in regard to changing the style of headings for articles and the size of the type in the Proceedings was almost unanimous in favor—as a war-economy measure—of printing the Proceedings in 10-point type and of using the text type instead of Cheltenham for the headings, consequently your chairman and managing editor have ordered the changes made beginning with the January issue.

E. B. WILSON, *Managing Editor.*

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INSTITUTIONS WHICH HAVE CONTRIBUTED THREE OR MORE ARTICLES TO THE PROCEEDINGS EACH YEAR.

Institutions.	1915	1916	1917	Institutions.	1915	1916	1917
Carnegie Institution	34	29	32	United States Geological Survey	3	4	.....
University of Chicago	20	12	6	Maine Agricultural Experiment Station	.....	5	.....
University of California	17	7	.....	Brown University	.....	5	9
Harvard University	16	31	26	Massachusetts Institute of Technology	.....	5	.....
Johns Hopkins	11	11	4	Observatorio Nacional Argentine	.....	3	.....
Rockefeller Institute	11	4	4	United States Department of Agriculture	.....	.....	4
University of Illinois	8	4	5	University of Virginia	.....	.....	4
Yale University	6	7	7	General Electric Co	.....	.....	4
Princeton University	5	5	5	Columbia University	.....	.....	3
Smithsonian Institution	4	4	.....				
United States National Museum	4	.....	.....				
Stanford University	4	.....	.....				
American Museum of Natural History	4	.....	3				

SUMMARY OF THE ARTICLES WHICH HAVE APPEARED IN THE FIRST THREE VOLUMES OF THE PROCEEDINGS.

Subject.	1915	1916	1917	Total.
Mathematics	21	20	13	54
Astronomy	31	29	17	77
Physics and engineering	7	23	32	62
Chemistry	21	15	12	48
Agriculture	0	0	4	4
Geology and paleontology, including oceanography, mineralogy, and petrology	10	33	18	61
Botany	4	9	5	18
Zoology	15	20	27	62
Genetics	17	10	11	38
Physiology and pathology	24	13	18	55
Anthropology and psychology	15	14	5	34
Total	165	186	162	513
Articles by members	55	63	49	167
Articles by nonmembers	110	123	113	446

AUDITING COMMITTEE.

The president appointed an auditing committee consisting of C. G. Abbot (chairman), W. F. Durand, and A. L. Day.

ANNUAL TABLES OF CONSTANTS.

Considering the request of Mr. Julius Stieglitz, member for the United States of the International Commission on Annual Tables of Constants and Numerical Data, asking on behalf of the commisison for a continuation of the support of the academy in the publication

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of the tables under the patronage of the International Association of Academies, the following grant was approved:

That a grant of $200, or such portion of it as may be approved by the president and foreign secretary, be made from the general funds of the academy as a subvention in support of the annual tables of constants published under the patronage of the International Association of Academies.

ENGINEERING SECTION.

The following minute from the council relating to the development of a section of engineering was approved:

It is the sense of the council that the home secretary be requested to obtain suggestions from members of the academy of names of engineers to be considered by the council for nomination at the next annual meeting.

CLASSIFICATION OF SCIENTIFIC MEN FOR WAR SERVICE.

Considering a communication from the American Association of University Professors, requesting cooperation in the classification of scientific men for war service, the following recommendations were adopted by the academy and forwarded to the Secretary of War:

The National Academy of Sciences, being convinced that such action is absolutely necessary for the successful prosecution of the war, urges that the privilege of enlistment granted to the medical profession, including students and internes, under orders of the War Department, office of the Surgeon General, dated September 4, 1917, if not already provided for by the intended interpretation of the new classification of drafted men, be expanded to embrace men in the following scientific professions, including junior, senior, and graduate students in educational or research institutions, so that all such men may be privileged to enroll in the appropriate reserve corps or in such branch of the service as in your judgment will enable them to make their special knowledge and training of greatest use to their country.

Agriculturists.
Anatomists.
Astronomers.
Bacteriologists.
Biologists.
Botanists.
Chemists.
Chemical engineers.
Civil engineers.
Electrical engineers.
Geologists.
Mechanical engineers.
Metallurgical engineers.
Meteorologists.
Mining engineers.
Pathologists.
Physicists.
Physiologists.
Psychologists.
Zoologists.
Experts in public health, hygiene, and sanitation.

The academy recommends that, pending the working out of the details requisite for the establishment of these privileges, the pro-

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fessional men affected by the same be placed in Class III of the new classification of drafted men.

The purpose of the establishment of the academy by special act of Congress, as stated in its charter, was to create an organization whose duty it should be to advise the Government on scientific matters. It would be recreant to this duty, therefore, if it failed to point out the urgent need of the action recommended above, and to express its firm conviction that to win this war our scientifically trained men must be used to do the work which they alone can do. The inclusion of such men in Class I of the new draft classification would result in a wholly disproportionate loss of national efficiency in comparison with the size of the army so created. Of the many grievous losses sustained by our allies, the one felt most keenly, according to their own oft-repeated statements, is that of the scientific men who went to the front at the first call, and laid down their lives there.

These recommendations are prompted by the following further considerations:

1. The failure of many of the district boards created by the selective-draft legislation, to recognize the necessity of retaining these scientific men for the kind of work for which they have been especially trained.

2. The retention of many scientific men as privates in the training camps of the National Army, who it is believed could render much more valuable service to their country if employed in the lines of their special profession.

3. The eager patriotism of our university men has led large numbers to enlist in the rank and file of our Army and Navy, and has correspondingly thinned the ranks of students, teachers, and investigators. There is immediate danger that without specific provision to the contrary, the universities will lack the teachers and students necessary to insure a steady flow of new effectives to the industrial and military fronts.

4. Many industrial establishments now of the utmost importance for the security and defense of our country are seriously impeded in their work by the fact that numbers of their highly trained scientists already have either been drafted or have volunteered for service and sought commissions for fear that they would be drafted and assigned to military duties of such a character as would not enable them to render to their country the greatest service of which they were capable. The result of this has been to reduce the working force of scientists in such establishments to the point where, unless further withdrawals are made with the greatest care, many of these plants will have to close their doors and go out of business.

It is respectfully urged that professional students be instructed to enlist in the appropriate reserve corps of the service, with the

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privilege of furlough for the completion of their training, similar to that adopted to secure the most efficient service of the medical men, and that this opportunity be granted only to men of proven ability. Students, teachers, and research men should be given the opportunity of enlistment with the privilege of furlough or discharge subject to the recommendations of the presidents of the institutions concerned. For others, the decision should rest with the authorities designated by the Secretary of War.

In case the academy can be of assistance in working out any of the details involved in the foregoing recommendations, it will esteem it both an honor and a patriotic duty to cooperate with whomsoever you may designate.

DECEMBER 20, 1917.

ARTHUR L. DAY,

Home Secretary National Academy of Sciences,

Washington, D. C.

DEAR SIR: This will acknowledge receipt of your letter of the 12th instant, addressed to the Secretary of War and referred to this office, transmitting a communication from the committee of the National Academy of Sciences on the classification of men for war service, recommending that provision be made for the enlistment of certain classes of scientific students in appropriate reserve corps and suggesting the importance of this Government profiting by the mistakes made by our allies at the beginning of the war in failing adequately to provide for the conservation of their scientific knowledge.

The recommendations of your committee have been carefully considered, and we are in entire accord in the conviction that every practicable provision should be made by which the country will be assured of the maximum benefit of the scientific knowledge of its citizens, and through which advanced students in certain scientific courses may be enabled to complete their training, to the end that they may be more able to serve our country.

In fact, the wisdom of this selection and distribution of the young men of the Nation in the particular capacities for which they are best fitted was recognized by Congress in the enactment of the selective-service law. This law, as it is being administered under the regulations prescribed by the President, seeks to select those men for present military service who can be spared best from their civil capacities and by such selection to disturb as little as possible consistent with the exigencies of the emergency the industrial, scientific, and economic interests of the Nation.

In this connection, and especially referring to the provisions which have been made for enabling young men pursuing special courses of scientific training to continue their studies, your attention is invited to the following excerpts from section 151 of the regulations as amended:

> "(*b*) Under such regulations as the Surgeon General may prescribe and upon receiving permission from the Surgeon General to do so, any medical student, hospital intern, dentist, dental student, veterinarian, or veterinary student may enlist in the Enlisted Reserve Corps of the Medical Department, and thereafter upon presentation by the registrant to his local board of a certificate of a commissioned officer of the Medical Department of the Army that he has been so enlisted, such certificate shall be filed with the questionnaire and the registrant shall be placed in class V on the ground that he is in the military service of the United States. * * *

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"(*d*) Under such regulations as the Chief of Engineers may prescribe, a proportion of the students, as named by the school faculty, pursuing an engineering course in one of the approved technical engineering schools listed in the War Department may enlist in the Enlisted Reserve Corps of the Engineer Department and thereafter, upon presentation by the registrant to his local board of a certificate of enlistment, such certificate shall be filed with the questionnaire and the registrant shall be placed in class V on the ground that he is in the military service of the United States."

Even a cursory examination of these provisions will disclose their wide application. The heads of the Medical and Engineering Departments, two of the important scientific branches of the Military Establishment, have been given almost unlimited discretion in selecting and providing for the enlistment in the appropriate reserve corps of students in the sciences they represent. By granting this authority the principle of selective system is carried to its logical conclusion; and the officers particularly learned in special lines are enabled to apply their peculiar knowledge in formulating rules which, in their opinion, best subserve the scientific and military interests of the Nation. It will be noticed that in this way a large proportion of the classes of students mentioned in the communication from the committee of the National Academy of Sciences has been provided for in present regulations.

In considering the question of permitting students to pursue their studies to graduation, it should be remembered that a large per cent of the college and university students of the country are included within the draft age, and, in view of the present urgent need for young and healthy men for the Army, it manifestly would be unwise to accord to all students the privilege of completing their courses. Modern war can not be waged without large armies, and unfortunately large armies can not be raised without great hardship. The problem, therefore, reduces itself to a selection of certain classes of students pursuing courses of sciences deemed most essential to the fundamental needs of the Nation in the present emergency. This has been done, in so far as there are appropriate reserve corps available, and as the necessity for creating new reserve corps becomes apparent, the proper steps will be taken toward their organization.

Referring to the suggestion that many district boards have failed to recognize the necessity of leaving scientific men in the work for which they have been especially trained, and that many industrial establishments of the utmost importance to the security and defense of our country are being seriously embarrassed on that account, attention is respectfully invited to the new Selective Service Regulations. By these regulations, all registrants will be definitely classified within the next few months and ample provision has been made therein to insure that scientific men actively engaged in industries of the character mentioned above will be placed in a deferred class. (Secs. 81–85–88.)

It is, of course, evident that the selective-service law can not entirely prevent the loss to such industries of men who volunteer or seek commissions "for fear that they would be drafted and assigned to military duties of such a character as would not enable them to render to their country the greatest service of which they are capable." Just this situation has, however, been provided for so far as practicable (1) by removing the uneasiness of registrants by a definite classification; (2) by foreclosing the privilege of enlistment to registrants within a current quota of their local boards, and thus forcing them to submit to an orderly selection; and (3) by securing the necessary data in their questionnaires for enabling the Government when necessary to assign them to branches of the Army in which they are especially qualified to serve. In this

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connection your attention is invited to pages 4 and 5 of the questionnaire and section 149 of the Selective Service Regulations.

Allow me to express my appreciation to your committee for its communication and to invite further recommendations, if, in the light of the above facts and the Selective Service Regulations, additional suggestions for the perfection of these regulations are deemed necessary.

Very truly, yours,

E. H. CROWDER, *Provost Marshal General.*

REPORT OF COMMITTEE ON COMSTOCK FUND.

The following report from the committee of the Comstock fund was adopted:

The committee on the Comstock fund, at a meeting held on November 20, 1917, decided to recommend to the academy that the second award of the Comstock prize of $1,500 be made to Samuel Jackson Barnett for his investigation on magnetization by rotation.

In this research certain very important and fundamental facts are established: (1) That there are, within the iron, currents of negative electricity in orbital revolution; (2) that these gyrostatic systems have inertia and are capable of definite orientation or arrangement by the rotation of the body without the action of any external magnetic field; and (3) that such orientation manifests itself as a magnetization of the body as a whole.

This experiment is of the utmost significance in the theory of magnetism and is far reaching in its bearings upon our views of the ultimate constitution of matter.

EDW. L. NICHOLS, *Chairman.*

AMENDMENTS TO CONSTITUTION AND RULES.

The following amendment to the constitution, Article III, section 1, reported from the council and returned to the academy from the committee of the whole with favorable recommendation was adopted:

That the academy shall hold one stated meeting, called the annual meeting in April of each year in the city of Washington, and another stated meeting, called the autumn meeting, at a place to be determined by the council. The council shall also have power to fix the date of each meeting.

The following rule, III, 1, recommended by the council was adopted:

The annual meeting of the academy shall begin on the fourth Monday in April.

The committee of the whole, upon recommendation of the council, considered the following amendment to the constitution and reported it for favorable action by the academy at the annual meeting in 1918:

That the constitution be amended by substituting in Article II, section 1, line 3 (Report, 1916), the word "four" for the word "six" so that it will read * * * "for a term of four years" * * * to take effect on the expiration of the term of office of the present incumbents or in case of a vacancy.

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Article II, section 1, when amended to read:

SECTION 1. The officers of the academy shall be a president, a vice president, a foreign secretary, a home secretary, and a treasurer, all of whom shall be elected for a term of four years by a majority of votes present, at the first stated meeting after the expiration of the current terms, provided that existing officers retain their places until their successors are elected. In case of a vacancy the election for four years shall be held in the same manner at the meeting when such vacancy occurs, or at the next stated meeting thereafter, as the academy may direct. A vacancy in the office of treasurer or home secretary may, however, be filled by appointment of the president of the academy until the next stated meeting of the academy.

THE WATSON FUND.

The following motion relating to the administration of the Watson fund, adopted at the business session of April 16, 1917, which was found to conflict with a clause in the will of James Craig Watson, was rescinded:

That the trustees of the Watson fund be authorized to act for the Academy in the approval of grants and to report such action to the academy at the next stated meeting.

PROCEEDINGS DEFICIT.

Under business from the council a statement of the financial condition of the Proceedings was laid before the academy in considerable detail. To meet the anticipated deficit of $5,000 in the conduct of the Proceedings to July 1, 1918, Mr. Pupin announced that three members of the academy had agreed to be responsible for one-half of this sum. The chairman of the finance committee, Mr. Davenport, reported that his committee had raised $1,185 for the same purpose. After discussion by the president, the chairman of the editorial board, and Messrs. Hale, Meltzer, John M. Clarke, and the home secretary, it appeared to be the sense of the meeting that further financial arrangements be left in the hands of the finance committee.

The academy further considered securing additional subscriptions for the Proceedings, and upon the recommendation of the council adopted the following resolution:

That the editorial board recommend to the academy that each member of the academy be responsible for one subscription to the Proceedings, to be paid for by the member or by a subscriber.

CONTRIBUTIONS TO THE SUPPORT OF THE PROCEEDINGS.

The finance committee of the Proceedings begs to report that it received the following contributions, totaling $1,185:

George R. Agassiz, 14 Ashburton Place, Boston	$100
N. L. Britton, New York Botanical Garden, New York	100
John J. Carty, American Telegraph & Telephone Co., New York, N. Y.	100

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C. R. Crane, Chicago, Ill	$125
H. H. Donaldson, Wistar Institute, Philadelphia	25
E. H. Hall, Cambridge, Mass	25
Mrs. E. H. Harriman, 1 East Sixty-ninth Street, New York, N. Y	100
Julius Rosenwald, Chicago, Ill	125
Henry L. Higginson, 44 State Street, Boston, Mass	100
Anonymous, through Frank Lillie, Chicago, Ill	125
Graham Lusk, Cornell Medical College, New York, N. Y	50
S. J. Meltzer, Rockefeller Institute, New York	10
Henry F. Osborn, American Museum of Natural History, New York, N. Y.	25
Harold H. Swift, Chicago, Ill	125
Elihu Thompson, Lynn, Mass	25
J. F. Kemp, 219 Lynch Building, Tulsa, Okla	25
	1,185

C. D. DAVENPORT, *Chairman.*
FRANK R. LILLIE.
RAYMOND PEARL.

NOVEMBER 15, 1917.

The following resolution was unanimously adopted:

That the home secretary be requested to transmit the thanks of the academy to the provost of the University of Pennsylvania, the president of the American Philosophical Society, the president of the Academy of Natural Sciences of Philadelphia, and the members of the local committee for the courtesies extended to the members of the National Academy of Sciences at the autumn meeting, 1917.

SCIENTIFIC SESSIONS.

MEETING OF NOVEMBER 20–21, 1917.

TUESDAY, NOVEMBER 20.

Edwin F. Smith, Bureau of Plant Industry, United States Department of Agriculture: The wheat problem of the United States.

Liberty H. Bailey: The modern systematist.

Bradley M. Davis, University of Pennsylvania: A criticism of the evidence for the mutation theory of De Vries from the behavior of Œnothera in crosses and in selfed lines. (By invitation.)

Jacques Loeb, Rockefeller Institute: The chemical mechanism of regeneration.

Henry H. Donaldson, the Wistar Institute: A comparison of growth changes in the nervous system of the rat with the corresponding changes in man.

Charles B. Davenport, Station for Experimental Evolution, Carnegie Institution: Hereditary tendency to form nerve tumors.

Lafayette B. Mendel and Thomas B. Osborne, Yale University: Food hormones or vitamines in some animal tissues. (To be presented by L. B. Mendel.)

Edgar F. Smith and Walter K. Van Haagen, University of Pennsylvania: The atomic weight of boron.

Samuel J. Meltzer and John Auer, Rockefeller Institute: The effect of intravenous injection of magnesium sulphate upon tetanus—with a lantern slide demonstration by J. Auer. (By invitation.)

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Simon Flexner, Rockefeller Institute: Chemotherapy of spirochetal infections. (For Dr. Jacobs and Dr. Brown.)

Clarence E. McClung, University of Pennsylvania: Possible action of the sex—determining mechanism. (By invitation.)

Thomas H. Morgan, Columbia University: The cause of Mosaics and Gynandromorphs in Drosophila.

Herbert E. Ives, Physical Laboratory—The United Gas Improvement Co.: Spectrum analysis by differential persistence of vision. (By invitation.)

WEDNESDAY, NOVEMBER 21.

Charles G. Abbot, Smithsonian Astrophysical Observatory: The atmosphere and terrestrial radiation.

Edward Kasner, Columbia University: Geometric aspects of the theory of heat.

Oliver E. Glenn, University of Pennsylvania: Invariants which are functions of parameters of the transformation. (By invitation.)

Edwin H. Hall, Harvard University: The validity of the thermoelectric equation $P=T\frac{dv}{dT}$.

Edwin H. Hall, Harvard University: A thermoelectric diagram on the P. V. plane.

William B. Scott, Princeton University: The Astrapotheria of the Patagonian Miocene.

Henry F. Osborn, American Museum of Natural History: Evolution of the Titanotheres; Final Conclusions.

Eric Doolittle, University of Pennsylvania: Study of the motions of 48 double stars. (By invitation.)

Gustav Strömberg, Mount Wilson Solar Observatory, Carnegie Institution: (Introduced by Walter S. Adams.) A determination of the solar motion and of stream motion based on absolute magnitudes. (Read by Prof. Hale.)

Armin O. Leuschner, University of California: On finite velocity of gravitation as a possible factor in stellar evolution.

Alfred G. Mayer, marine laboratory, Carnegie Institution: The coral reefs of Tutuila, Samoa.

William M. Davis, Harvard University: The subsidence of volcanic islands.

William M. Davis, Harvard University: A duty of the International Association of Academies.

William H. Holmes, United States National Museum: The work of the anthropology committee of the National Research Council.

Edward L. Thorndike, Columbia University: The work of the psychological committee of the National Research Council.

George E. Hale, Mount Wilson Solar Observatory, Carnegie Institution: The work of the National Research Council.

Louis V. Pirrson, Yale University; Biographical memoir of James D. Dana. (Read by title.)

William J. Humphreys, United States Weather Bureau: (Introduced by A. L. Day.) Biographical memoir of Cleveland Abbe. (Read by title.)

E. H. Hall: Biographical memoir of Benjamin Osgood Pierce.

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DECEASED MEMBERS.

WILLIAM BULLOCK CLARK.

Dr. William Bullock Clark, professor of geology in the Johns Hopkins University, eminent for his contributions to geology, died suddenly from apoplexy on July 27 at his summer home at North Haven, Me.

William Bullock Clark was born at Brattleboro, Vt., December 15, 1860. His parents were Barna A. and Helen (Bullock) Clark. Among his early ancestors were Thomas Clarke, who came to Plymouth, Mass., in the ship *Ann* in 1623, and who was several times elected deputy to the general court of Plymouth Colony; Richard Bullock, who came to Salem, Mass., in 1643; John Howland, a member of council, assistant to the governor, and several times deputy to the general court of Plymouth Colony, who came to Plymouth in the *Mayflower* in 1620; John Tilly, who likewise came in the *Mayflower*; and John Gorham, captain of Massachusetts troops in King Philip's War. Among later ancestors were William Bullock, colonel of Massachusetts troops in the French and Indian War, and Daniel Stewart, a minuteman at the battle of Lexington in 1775.

Prof. Clark studied under private tutors and at the Brattleboro High School, from which he graduated in 1879. He entered Amherst College in the autumn of 1880 and graduated with the degree of A.B. in 1884. He immediately went to Germany and from 1884 to 1887 pursued geological studies at the University of Munich, from which he received the degree of doctor of philosophy in 1887. Subsequently he studied at Berlin and London, spending much time in the field with members of the geological surveys of Prussia and Great Britain.

Before leaving Munich Dr. Clark was offered and accepted the position of instructor in the Johns Hopkins University. He was instructor from 1887 to 1889, associate from 1889 to 1892, associate professor from 1892 to 1894, when he became professor of geology and head of the department. He was for a long time a member of the academic council—the governing body of the university—and always took a very active interest in its affairs, acting as one of the committee of administration while the university was without a president.

In 1888 he was also appointed an assistant geologist on the United States Geological Survey and detailed for work on the Cretaceous and Tertiary formations of the Atlantic coastal plain. At the same time he was requested to prepare the correlation bulletin on the Eocene, one of a series of reports which were presented to the Inter-

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national Geological Congress in Washington in 1891. Prof. Clark spent the summer of 1889 in a study of the Eocene deposits of the far West while the remaining period was occupied in the investigation of the Eocene formations of the Atlantic border. He was advanced to geologist on the staff of the United States Geological Survey in 1894 and held that position until 1907, from which time he acted as cooperating geologist.

Prof. Clark organized the Maryland State Weather Service in 1892, of which he was appointed the director. He held the position continuously to the time of his death. In 1896 he organized the Maryland Geological Survey, and was State geologist from the establishment of that bureau. The geological survey was enlarged in scope in 1898 by the addition of a highway division, which was instructed to investigate and report on the conditions of the roads of the State and the best means for their improvement, and Prof. Clark and his associates through their publications and addresses aroused much interest in the subject throughout the State. In 1904 the duties of the highway division were much increased by the appropriation of $200,000 annually, to be met by a similar amount from the counties for the building of State-aid roads by the survey. A sum exceeding $200,000 was also subsequently appropriated for the building of State-aid roads by the survey, at the expense of the State alone, of a highway connecting Baltimore and Washington. The duties of the highway division were transferred in 1910 to a newly organized State roads commission, of which Prof. Clark was made a member and which position he held until 1914. Nearly $2,000,000 had been expended, however, by the State geological survey in the supervision and building of roads up to the date of the transfer.

Under an act of legislature passed in 1900 Prof. Clark was appointed commissioner for Maryland by the governor to represent the State in the resurvey of the Maryland-Pennsylvania boundary, commonly known as the Mason and Dixon Line. This survey was completed four years later and an elaborate report prepared. In 1906 he was made a member of the Maryland State board of Forestry and elected as its executive officer, which position he held at the time of his death. The governor appointed him in 1908 a member of the State conservation commission.

Prof. Clark organized and directed the preparation of the official State exhibits of Maryland mineral resources at the Buffalo, Charleston, St. Louis, Jamestown, and San Francisco Expositions in 1901, 1902, 1904, 1907, and 1915. These exhibits attracted much attention at the time and received a large number of conspicuous awards. These exhibits have been permanently installed as a State mineral exhibit at the statehouse in Annapolis.

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When President Roosevelt invited the governors of the States to a conference on conservation at the White House in May, 1908, it was arranged that each governor should appoint three advisers to accompany him. Prof. Clark was one of the Maryland advisers and took part in the conference.

After the great Baltimore fire in 1904 the mayor of the city appointed Prof. Clark a member of an emergency committee to prepare plans for the rehabilitation of the burned district, and for several months he served as vice chairman of the important subcommittee on streets, parks, and docks, whose plans resulted in the great changes subsequently carried out. The following year he was appointed by the mayor a member of a committee to devise a plan for a sewerage system for the city, which resulted in the building of the present modern system of sewers. Again, in 1909, the mayor also appointed him a member of a committee for devising a plan for the development of a civic center for Baltimore.

From 1901 Prof. Clark was president of the Henry Watson Children's Aid Society, of Baltimore, and was a delegate to the White House conference called by President Roosevelt in February, 1909, to consider the subject of the dependent child. He was also a member of the executive committee of the State tuberculosis association and a vice president and chairman of the executive committee of the federated charities of Baltimore.

Numerous scientific societies elected him to membership, among them the National Academy of Sciences, of which he was chairman of the geological section, the American Philosophical Society, the Philadelphia Academy of Natural Sciences, the American Academy of Arts and Sciences, the Deutsche Geologische Gesellschaft, the Washington Academy of Sciences, Paleontologische Gesellschaft, and the American Association for the Advancement of Science. He was councillor and treasurer of the Geological Society of America at the time of his death. In 1904 he was elected a foreign correspondent of the Geological Society of London. He was also president of the Association of State Geologists. Amherst conferred on him the degree of LL. D. in 1908. He had numerous offers from other institutions, perhaps the most important being the professorship and head of the department of geology at Harvard University, but all of these were refused, and his devotion to Hopkins and the ideals for which it stood was unswerving.

At the time of the International Geological Congress in St. Petersburg in 1897 Prof. Clark was an official delegate from the United States and spent several months in an extended trip through Russia and its Provinces. In 1906 he spent the summer on an expedition to central Alaska, visiting the region to the north of Prince William

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Sound. He traveled extensively in western America and Mexico, reaching distant portions of the western Sierra Madre district.

With the outbreak of the war Prof. Clark became actively interested in problems of defense and economic preparedness. He was appointed a member of the National Research Council and was chairman of the subcommittee on road materials and a member of the committee on camp sites and water supplies. He was also chairman of the committee on highways and natural resources of the Maryland Council of Defense.

Prof. Clark made numerous contributions to geological literature, his work being confined largely to the Cretaceous and Tertiary formations of the Atlantic coastal plain and the Carboniferous deposits of the central Appalachian region. Prof. Clark's chief paleontological interest was centered in the Echinoidea, to the elucidation of which group he published several monographs. One of his monuments will be the series of reports of the Maryland Geological Survey, which set a new standard for State publications, both as to subject matter and bookmaking. The systematic reports in which he was most interested will be of perennial service to science.

He was a member of numerous clubs, including the University, Maryland, of which he was a vice president, Baltimore Country, Johns Hopkins, and City Clubs, of Baltimore, and the Cosmos Club, of Washington.

He was married October 12, 1892, to Ellen Clarke Strong, daughter of the late Edward A. Strong, of Boston, and had four children—Edward Strong, Helen (who was recently married to Capt. H. Findlay French), Atherton, and Marion, all of whom survive him.

Prof. Clark's administrative ability and professional attainments are largely responsible for the extensive development of Maryland's mineral resources, and his loss will be severely felt in all quarters. He was always keenly interested in the educational value of the work of the various State bureaus which he directed and had just finished writing a geography of Maryland for school-teachers. At the time of his death he was engaged in writing a report on the underground waters of the State and another on the coals.

(Abstract from Science, n. s. Vol. XLVI, No. 1179, p. 104.)

ARNOLD HAGUE.

Arnold Hague, the able geologist and a man of rare personal gifts, was born in Boston December 3, 1840, and died at his home in Washington May 14, 1917. The immediate cause of his death was cerebral hemorrhage, and was undoubtedly hastened by his recent fall in Albany while attending a meeting of the Geological Society of America. For nearly 50 years he was prominent in the geological

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affairs of the country. His parents, the Rev. Dr. William Hague, a noted clergyman and writer, and Mary Bowditch (Moriarty) Hague, lived in Boston during his youth. There his education began, but later he attended the Albany Academy.

James D. Hague, his elder brother, studied mining engineering at the Lawrence Scientific School of Harvard, and Arnold may have acquired from him his taste for geology. At the Sheffield Scientific School of Yale, where Arnold Hague graduated (Ph. B.) in 1863, he met as classmate Clarence King, who had much to do with his career. Three years in succession Hague studied in Europe at the Universities of Göttingen and Heidelberg and the Freiberg School of Mines. While in Bunsen's laboratory he devoted himself chiefly to chemistry and mineralogy. The spring of 1865 found him in Freiberg, where he met S. F. Emmons. They were especially congenial, and with the same bent they soon became and continued through life devoted friends and colleagues. Hague in his excellent memoir of Emmons tells much of himself. Indeed, much of that loving tribute to his friend reads like an autobiography. He writes: "I was always ready to lay aside metallurgical studies for field geology. Together we took all the week-end excursions with dear old Bernhard von Cotta, visiting many parts of Saxony and studying petrology as laid down in that now antiquated textbook, Cotta's 'Die Gesteinlehre' (Zweite Auflage. 1862).. Many an evening Emmons and I spent together over the map of Saxony, acquiring our initiative experience in geological cartography, which later stood us in good service. Both came to realize the influence of Cotta upon our future careers, as he gave us much of his time. In this way, during these few months of German student life, was formed a friendship that always endured."

Hague returned to his home in Boston in December, 1866, and soon received from his friend, Clarence King, an offer to join in the geological exploration of the fortieth parallel, which King was just succeeding in carrying through Congress without the customary delay. Hague lost no time in bringing Emmons to the attention of King, who secured him, at first as a volunteer, for the fortieth parallel survey. Work began on the Pacific coast in 1867, and the party went thither by way of Panama. The only other available route was by Wells, Fargo & Co.'s overland stage, a tedious, not to say dangerous, journey.

Hague and Emmons had separate parties in the field, and King, with his own camping outfit and greater freedom of motion, conducted special investigations over the whole region, all parties meeting frequently for conference. The topographic and geologic surveys of a belt 100 miles in width along the proposed route of the Central & Union Pacific Railroad proceeded together from the Humboldt country of western Nevada to the Great Plains east of the Rockies. Field work was finally completed late in the autumn of

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1872, but it should be borne in mind that finished topographic maps on which the areal geology was to be shown, as Hague remarks, were seldom in the hands of the geologists till a year after completing the field work.

After the completion of the field work the final preparation of the report with its accompanying atlas was accomplished in New York, where Mr. King and his two colleagues worked together and lived in ties of closest friendship.

Hague's first scientific publications, "Chemistry of the Washoe Process" and the "Geology of the White Pine District," occurred in 1870, when he was 30 years of age. They grew out of his fortieth parallel work and appeared in Volume III of that organization. The great work, Descriptive Geology, of which Hague and Emmons were joint authors, appeared as Volume II, in 1877. King published Systematic Geology, Volume I, in 1878.

For a comparative study, the fortieth parallel geologists in 1870 visited the Cascade Range. King climbed Mount Shasta; Hague climbed Mount Hood; and Emmons, Mount Rainier. They observed about these lofty volcanoes the first active glaciers noted in the United States, and, using the lavas collected, Hague and Iddings made comparative study of the volcanic rocks of the Cascade Range and the Great Basin.

In 1877 Hague received the appointment as Government geologist of Guatemala, and traveled extensively over the Republic, visiting mines and active volcanic centers. The following year he was engaged by the Chinese Government to examine gold, silver, and lead mines in northern China.

Congress created the bureau of the United States Geological Survey in 1879, thus withdrawing congressional authorization from existing surveys and exploration parties and accomplishing a complete reorganization. Clarence King was appointed the first director, and took the oath of office May 24. Arnold Hague, who had returned to the United States, was appointed a geologist in the United States Geological Survey July 8, 1879, but did not take the oath of office until April 10 of the following year.

Under the new organization he was sent to Nevada to study the geology of the Eureka district. His report, published in 1893, is Monograph 22 of the United States Geological Survey. In 1883 he was made geologist of the Yellowstone National Park. With the aid of a number of able assistants and specialists the general study of the Yellowstone National Park was completed some years ago and the results published as Monograph 32, part 2, leaving part 1 to be prepared as a final report by Mr. Hague. It is to include a special study of the geysers, which engaged his attention for a number of

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years. This work, his last and greatest, Hague leaves practically complete.

Mr. Hague, in addition to his larger reports, has contributed papers to a number of scientific periodicals, especially to this Journal. Among these may be mentioned the "Early Tertiary Volcanoes of the Absaroka Range," delivered as his presidential address before the Geological Society of Washington, and "The origin of the thermal waters in the Yellowstone National Park," his presidential address before the Geological Society of America. His bibliography of scientific papers includes 39 titles, the last of which is the memoir to his life-long and devoted friend, S. F. Emmons, published in 1913 by the National Academy of Sciences.

Hague was a fellow of the Geological Society of America, of which he was president in 1910, of the Geological Society of London, and a member of numerous other scientific societies. In 1885 he was elected to the National Academy of Sciences, of which he was an active member and officer. As a member of the commission appointed at the request of the United States Government by the National Academy of Sciences, he had much to do with the plan for our national forest reserves.

Columbia University honored him with the degree Sc. D. in 1901, and in 1906 he received the degree of LL. D. of the University of Aberdeen. He was vice president of the International Geological Congress at Paris 1900, Stockholm 1910, and Toronto 1913. November 14, 1893, he married Mary Bruce Howe, of New York.

Mr. Hague was not a ready writer nor voluminous, but exact. He aimed more to write well and truly than much. He was a charming host, and there are but few scientific men in America who have had so wide a circle of devoted friends as Arnold Hague.

(Extract by J. S. Diller from the American Journal of Science, Vol. XLIV, July, 1917.)

FRANKLIN PAINE MALL.

Franklin Paine Mall, professor of anatomy in the Johns Hopkins Medical School and director of the department of embryology of the Carnegie Institution of Washington, was born in Belle Plaine, Iowa, September 28, 1862, and died in Baltimore November 17, 1917, from complications following an operation for gallstones. He was the son of Francis and Louise (Miller) Mall, both of German descent. In 1895 he married Mabel Stanley Glover, of Washington, D. C. He is survived by his widow and two daughters.

Dr. Mall's early education was obtained in public and private schools near his home. He graduated in medicine from the University of Michigan in 1883, and then went to Germany, where he

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studied first in Heidelberg, and later under His and Ludwig in Leipzig. Upon his return to America he became a fellow in pathology at the Johns Hopkins University (1886–1888), and instructor in pathology from 1888–89. He then went to Clark University as adjunct professor of vertebrate anatomy (1889–1892). In 1892 he was called to the University of Chicago as professor of anatomy; and finally, when the Johns Hopkins Medical School opened (1893), he undertook the direction of the new department of anatomy, which he continued until the time of his death. In 1915 he was made director of the newly established department of embryology of the Carnegie Institution of Washington.

In science Dr. Mall ranks with the great leaders of his generation, and his work, embodied in 104 publications, leads up to important scientific generalizations. In anatomy he broke away from the study of pure morphology and studied structure from the standpoint of how all the tissues of an organ are adapted to its functions. This work led to the conception that most organs are made up of structural units which are equal in size and function. In embryology he was the first to trace the development of an individual organ from its early embryonic form to its adult state, a type of work which may be summed up with the term *organogenesis*.

The later years of his life were devoted to the organization of the department of embryology of the Carnegie Institution of Washington. In this department was incorporated the large and unique collection of human embryos which owed its origin to 30 years of untiring effort on the part of Dr. Mall. One of the most striking points in his career is that, in these years devoted to the organization of a new institute, he accomplished some of his best scientific work. He finished an exhaustive study of abnormal embryos, and had plans under way for the completion of the study of organogenesis and for the analysis of problems associated with growth, which need for their solution large amounts of material and expert technical assistance.

In addition to his numerous contributions to the development of science, Dr. Mall was a great teacher. He will be remembered as having trained a large group of men who are now prominent in scientific medicine. He was an active force in the reorganization of the American Association of Anatomists, and played a prominent part in the development of scientific publications in this country. He was co-editor and one of the founders of the American Journal of Anatomy and the Anatomical Record; associate editor of the Journal of Morphology; joint editor with Franz Keibel of the Handbuch der Entwicklungsgeschichte des Menschen, published in German and English; and finally he established the Contributions to Embryology, published by the Carnegie Institution of Washington. He was a man

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of rare personality; modest, generous, original, unswervingly devoted to ideals, and possessed of a genius for stimulating thought.

Dr. Mall was a member of the following societies: National Academy of Sciences, Society of Experimental Biology and Medicine, American Philosophical Society, American Association of Anatomists, American Society of Physiologists, American Society of Zoologists, Society of American Naturalists, and the Institute Internationale d'Embryologie. He was also a member of the Commission for Neurological Research, a member of the advisory board of Wistar Institute, president of the American Association of Anatomists (1905–1907), and trustee of the Marine Biological Laboratory, Woods Hole, Mass.

(Extract made from a paper read by Wallace C. Sabine at the Franklin P. Mall memorial meeting held at Johns Hopkins University by George L. Streeter.)

ADOLF VON BAEYER.

The announcement in the Times of September 8 of the death of Prof. Adolf von Baeyer at Starnberg, near Munich, in his eighty-second year, must have come as a shock to his many pupils in this country. It was known to several of us that he had not been in good health for some years, but the quiet life which he led at his beautiful home on the shores of the Starnberger See seemed to benefit his health so much that his sudden decease, even at his advanced age, was quite unexpected. It is questionable whether any teacher or investigator ever exerted a greater influence on the development of chemical science, and especially of organic chemistry, than Baeyer has done, for not only was he a great teacher, whose pupils are to be found in every civilized country, but his researches have also laid many of the foundations on which the amazing structure of modern organic chemistry has been raised. Apart from the interest which always attached to his published work, it is probable that his main influence on chemical thought was due to his magnetic personality and power of imparting to others some of his enthusiasm for discovery.

For many years, and particularly during the period 1880–1900, it was the custom for the large majority of those who wished to come into contact with the later developments of experimental method to attach themselves, for a short time at least, to the laboratories at Munich. The power which Baeyer exercised in connection with the progress of chemistry in Germany can scarcely be better illustrated than by the fact that during these years almost every professor of chemistry in Germany of the first rank was a pupil of Baeyer. Among these we find, for example, the names of E. Bamberger, L.

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Claisen, Th. Curtius, Emil Fischer, Otto Fischer, P. Friedländer, C. Graebe, L. Knorr, C. Liebermann, Victor Meyer, H. v. Pechmann, J. Thiele, and R. Wilstätter.

Baeyer's influence on the development of chemical industry, and especially of the color industry, was not less remarkable, for in every works were to be found such men as Caro and Duisberg, Homolka, and Weinberg, and a host of others who had learned their chemistry and acquired their methods of research in the laboratories at Munich. If inquiry is made into the reason for the wide influence which Baeyer has exerted on chemical thought, it will be universally agreed that this has been due in the main to his extraordinary enthusiasm for research and the keen joy which he felt and expressed when he had succeeded in producing some new substance of importance which he had probably been seeking for many months, and possibly for years. On such occasions he used to walk about the laboratories beaming with delight and discuss his latest discovery and its probable consequences with his assistants and advanced pupils. His enthusiasm fired the enthusiasm of his hearers, and unquestionably did much to awaken and stimulate the desire to make discoveries and achieve something perhaps of equal importance. Baeyer was essentially an experimenter, and had little real interest in the development of new theories, although some of his views, such, for example, as those on the constitution of benzine, the structure of oxonium salts, the cause of color in the triphenylmenthane series, and the mechanism of the formation of sugar in the plant, were valuable contributions to theory, and his well-known "Spannungs Theorie" was a brilliant conception of real value in connection with stability in ring structures.

It was Baeyer's habit to adjourn to his private laboratory directly after his early morning lecture, for perhaps an hour, in order to carry out any experiments which had occurred to him after the close of the previous day's work and to discuss the day's program with his assistant. He would then walk through the research laboratories and talk over any difficulties with those with whom he happened to be working, and with others whose work happened to interest him. Baeyer's custom was to work himself with comparatively few of those engaged in research in his laboratories, and he left to the *Privatdozenten* almost entirely the supervision of the *Doctorarbeiten*.

Unless something of real interest had happened, it was usual for those working with him to tell him at once that there was nothing to report, and, in this way, Baeyer frequently made the tour of the large laboratories so rapidly that he was back in his private laboratory soon after 11 o'clock, and the whole of the rest of the day was spent at his own work. His private laboratory—a large and very

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well-lit room—usually contained, besides one private assistant, some other researcher in whose work he was specially interested, and it was not unusual for such a student to remain in the private laboratory for weeks at a time. Such an experience was, of course, of the utmost value to those who were fortunate enough to enjoy the privilege; in such circumstances it was impossible not to be profoundly influenced by the skill, patience, and resource with which the experimental difficulties of so many intricate problems were gradually overcome. His equipment for research consisted almost entirely of test tubes and glass rods, and it rarely happened that he used anything larger than quite small beakers and flasks. Large wooden racks containing hundreds of test tubes were always at hand, and it used to be said that these test tubes, after the usual wash, were subjected to a further cleaning, first with alcohol, and then with distilled water. Baeyer always insisted that the occurrence of a chemical change can be more easily observed and its course more closely followed with small quantities of material and the aid of a test tube and glass rod than by the employment of a hundred grams of substance and large flasks of beakers. That this view was undoubtedly correct is demonstrated not only by the brilliant results which Baeyer himself achieved with such simple means, but even more conclusively by the fact that his pupils, if perhaps reluctantly at first, all ultimately adopted his method of work. There can be no doubt that the discovery and careful characterization of so many substances, and the publication of so much important work covering such a wide field, would not have been possible had not Baeyer early acquired the habit of working with small quantities of material.

Baeyer's immense power of work is shown by the fact that, until his eightieth birthday, he delivered his usual lectures on five mornings of each week and continued to experiment in his laboratory with his usual unflagging energy. Had the war not robbed him of his private assistant and laboratory staff, it is probable that he would have gone on even longer. He confided to one of his intimate friends that work in the laboratory gave him as much pleasure after 50 years' toil as at any time during his career, and to the last he took the greatest interest in any developments in the domain of natural science which were brought to his notice. It is well known that he viewed with disfavor and apprehension the growing domination of military power in Berlin and Prussia generally, and it was mainly, no doubt, for this reason that he refused to accept the invitation to Berlin on the death of Hofmann.

Adolf von Baeyer was born on October 31, 1835, in Berlin, and he spent his early life in the house (242 Friedrichstrasse) of his grandfather, which at that time was a center of the literary life of Berlin,

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and it thus came about that Baeyer was brought up in a literary atmosphere. He always referred to this early intimate contact with literature with pleasure, and considered that the love for literature which he acquired in those days was of great service to him throughout his later career. Baeyer's chief interest in these early days seems to have been for botany and in living things generally, and his first contact with chemistry was on his ninth birthday, when his father gave him a copy of Stockhardt's "Schule der Chemie."

In his "Erinnerungen aus meinem Leben," which he wrote for the celebrations organized in connection with his seventieth birthday, he tells us that he converted a passage in the house into a small laboratory, and there carried out the usual dangerous and unpleasant experiments associated with early youth. It was during this time that he made his first discovery, that of the double salt, $CuCo_3$, Na_2CO_3, H_2O. The activity of the small laboratory does not seem to have been altogether appreciated, and the poet, Paul Heyse, who was a frequent visitor at the house, had reason to protest:

Es stinkt in diesem Haus gar sehr
Das kommt vom Adolf Baeyer her.

When he entered the university Baeyer seems at first to have entirely forsaken his chemical experiments and to have devoted himself to physics and mathematics, but the interest in chemistry soon returned, and in 1856 he entered Bunsen's laboratory at Heidelberg. After studying the methods of analysis in this famous laboratory for a year, he came under the influence of Kekulé, whom he afterwards followed to Ghent, and whom he always considered was his real teacher.

Baeyer obtained the Ph. D. degree in 1858; his dissertation, "De arsenici cu, methylo conjunctionibus," presented and printed in Latin, was a difficult and important piece of accurate work, and a great achievement for so young an investigator, especially as it was commenced and carried out entirely on his own initiative. In the spring of 1860 Baeyer returned to Berlin and became *Privatdozent* at that university, but in the same year he was appointed teacher in organic chemistry in the Gewerbe Institut, an institution which later developed into the Berliner Technische Hochschule. The foundations of many of Baeyer's most important researches were laid during the next few years, for we find him publishing papers on the uric acid group, mellitic acid, isatin and indigo, the reduction of benzene carboxulic acids, acetylene derivatives, etc., subjects which later developed into the classical memoirs with which his name is so intimately associated. Among the distinguished workers who were attracted to Baeyer's laboratory during this time we find the names of Graebe, Liebermann, Nencki, and Victor Meyer, and it was in

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1866 (Annalen, cxl., 295) that the method of reduction by distillation with zinc dust was elaborated which enabled Graebe and Liebermann to demonstrate that alizarin is a derivative of anthracene, and thus to proceed with the synthesis of this important coloring matter.

The next stage in Baeyer's career began in 1872, when he was appointed professor of chemistry in Strasburg, and it was here that he numbered among his pupils Emil and Otto Fischer and H. Caro, and produced many papers, of which those dealing with the phthaleins are probably the most important. Baeyer stayed in Strasburg for three years, and then proceeded in 1875 to Munich, where he remained for 40 years, and it was in the Munich laboratories that most of his famous researches reached maturity.

It is impossible to mention even the titles of the long series of papers which appeared with such regularity during this long period and are so well known to every student of chemistry. Mention may, however, be made of his researches on the phthaleins, the reduction of the phthalic acids, the constitution of benzene, indigo, and its derivatives, and last, but not least, the researches on the polyacetylene derivatives, which are marvels of experimental skill and have perhaps never been sufficiently appreciated.

His later researches were concerned with the peroxides, the constitution of Caro's acid, and particularly with the constitution of the oxonium salts and of the colored derivatives of triphenylmethane, and his last research, published in 1911, together with Jean Piccard, was on the oxonium salts derived from dimethylpyrone (Annalen, ccclxxxiv, 208, 224).

(Extract by W. H. Perkin, Nature, vol. 100, No. 2506 (Nov. 8, 1917), p. 188.)

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REPORT OF THE NATIONAL RESEARCH COUNCIL.

The preliminary steps in the organization of the National Research Council, which were given in detail in the last annual report of the academy, may be briefly recapitulated here. In April, 1916, when the attack on the *Sussex* had greatly increased the tension of our relations with Germany, the academy voted to offer to the President its services in organizing the scientific resources of the United States in the interest of the national security and welfare. This offer was immediately accepted. The President expressed the desire that the academy should coordinate the scientific resources of the entire country, and secure the cooperation of all agencies, governmental, educational, and industrial, in which research facilities are available. He also emphasized the fact that the chief national advantage of such cooperation and coordination would come after the war, and that its most lasting effect would be seen in scientific and industrial progress.

The National Research Council, comprising the chiefs of the technical bureaus of the Army and Navy, the heads of Government bureaus engaged in scientific research, a group of investigators representing educational institutions and research foundations, and another group including representatives of industrial and engineering research, was accordingly constituted by the academy with the active cooperation of the leading national scientific and engineering societies. On July 24, 1916, President Wilson addressed a letter to the president of the national academy expressing his approval of a preliminary report regarding the National Research Council, and promising his cooperation and that of the various departments of the Government. Since that time he has continued to give his support to the work of the National Research Council, and has appointed various representatives of the Government to membership in the council.

On February 28, 1917, the Council of National Defense passed a resolution expressing its recognition of the fact that the National Research Council, at the request of the President, had organized the scientific resources of the country in the interest of national defense and national welfare, and requesting the research council to cooperate with it in matters pertaining to scientific research for national defense. As the result of this action the chairman of the council opened

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offices in the Munsey Building in March and entered into active cooperation with the Council of National Defense, which was then established in the same building.

Soon afterwards the research council was requested to act as the department of science and research of the Council of National Defense, in which capacity it has continued to serve for the organization of investigations on military and industrial problems and, in harmony with the expressed wish of the President, as a coordinating agency in the field of science and research.

A further extension of the duties of the research council occurred in July, through the acceptance of the request of the Chief Signal Officer, expressed in the following letter:

WAR DEPARTMENT,
OFFICE OF THE CHIEF SIGNAL OFFICER,
Washington, July 2, 1917.

Dr. GEORGE E. HALE,
Chairman National Research Council,
Munsey Building, Washington, D. C.

MY DEAR DR. HALE: In the Signal Corps questions involving the selection and organization of large numbers of scientific men and the solution of research problems are constantly arising. The National Research Council, organized at the request of the President and acting as a department of the Council of National Defense, in close cooperation with similar bodies abroad, has federated and coordinated the scientific resources of the country and concentrated them upon the solution of military problems. It is accordingly the one agency in a position to meet the present needs of the Signal Corps.

I therefore request the research council to act as the advisory agent of the Signal Corps in the organization of its various scientific services and the solution of research problems. To this end I would suggest that Dr. Robert A. Millikan, vice chairman and executive officer of the research council, apply for a major's commission in the Officers Reserve Corps, for detail in charge of this work.

Very truly yours,

GEORGE O. SQUIER,
Brigadier General, C. S. O.

In accordance with this request Maj. (now Lieut. Col.) Millikan and Maj. Mendenhall were commissioned in the Signal Corps, and the work of the science and research division of the Signal Corps was immediately undertaken, as explained in a later section of this report.

Since that time the relations of the National Research Council with the various departments of the Government have rapidly developed. The military committee of the research council has been the chief factor in securing the necessary cooperation with the Army and Navy. This committee consists of the Chief of Operations of the Navy, the President of the Army War College, the Chiefs of Ordnance of the Army and Navy, the Chief Signal Officer of the Army,

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the Chief Naval Constructor, the Surgeon General of the Army, the Engineer in Chief of the Navy, the Chief of Engineers of the Army, the Director of Naval Intelligence, and the Chief of the Military Intelligence Section, together with the Chief of the Weather Bureau, the Chief of the Bureau of Chemistry, the Director of the Bureau of Mines, the Director of the Geological Survey, Mr. Howard E. Coffin of the advisory commission of the Council of National Defense, the Director of the Bureau of Standards (vice chairman), and the Secretary of the Smithsonian Institution (chairman).

RESEARCH INFORMATION COMMITTEE.

One of the most valuable results of the cooperation effected through the military committee is the organization of the research information committee, with offices in Washington, London, and Paris. The importance of this step, which should have direct influence upon international cooperation in scientific research, especially if the position of scientific attachés of our embassies abroad can be maintained after the war, is such as to warrant the following detailed statement regarding the organization and work of the research information committee:

1. By joint action the Secretaries of War and Navy, with the approval of the Council of National Defense, have authorized and approved the organization, through the National Research Council, of a research information committee in Washington, with branch committees in Paris and London, which are intended to work in close cooperation with the offices of the Military and Naval Intelligence, and whose function shall be the securing, classifying, and disseminating of scientific, technical, and industrial research information, especially relating to war problems, and the interchange of such information between the allies in Europe and the United States.

2. In Washington the committee consists of, first, a civilian member representing the National Research Council; second, the Chief, Military Intelligence Section; and, third, the Director of Naval Intelligence. Similar committees are being organized in Paris and London.

3. The initial organization of the committee in Paris is:

(*a*) The scientific attaché, representing the research information committee, Dr. W. F. Durand, attaché;

(*b*) The military attaché or an officer deputed to act for him;

(*c*) The naval attaché or an officer deputed to act for him.

4. The initial organization of the committee in London is

(*a*) The scientific attaché, representing the research information committee, Dr. H. A. Bumstead, attaché;

(*b*) The military attaché or an officer deputed to act for him;

(*c*) The naval attaché or an officer deputed to act for him.

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5. The chief functions of the foreign committees thus organized are intended to be as follows:

(*a*) The development of contact with all important research laboratories or agencies, governmental or private; the compilation of problems and subjects under investigation; and the collection and compilation of the results obtained.

(*b*) The classification, organization, and preparation of such information for transmission to the research information committee in Washington.

(*c*) The maintenance of continuous contact with the work of the offices of military and naval attachés, in order that all duplication of work or crossing of effort may be avoided, with the consequent waste of time and energy and the confusion resulting from crossed or duplicated effort.

(*d*) To serve as an immediate auxiliary to the offices of the military and naval attachés in the collection, analysis, and compilation of scientific, technical, and industrial research information.

(*e*) To serve as an agency at the immediate service of the commander in chief of the military and naval forces in Europe for the collection and analysis of scientific and technical research information and as an auxiliary to such direct military and naval agencies as may be in use for the purpose.

(*f*) To serve as centers of distribution to the American Expeditionary Forces in France and to the American naval forces in European waters of scientific and technical research information originating in the United States and transmitted through the research information committee in Washington.

(*g*) To serve as centers of distribution to our allies in Europe of scientific, technical, and industrial research information originating in the United States and transmitted through the research information committee in Washington.

(*h*) The maintenance of the necessary contact between the offices in Paris and London in order that provision may be made for the direct and prompt interchange of important scientific and technical information.

(*i*) To aid research workers or collectors of scientific, technical, and industrial information from the United States when properly accredited from the research information committee in Washington, in best achieving their several and particular purposes.

An appropriation of $38,400 has been made by the Council of National Defense to cover the expenses of the research information committee for the current year.

The natural development of the work of the research information committee will lead to the concentration in the office of the National

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Research Council, where the Washington headquarters of the committee is established, of all available information regarding research problems under investigation both in the United States and abroad. At the same time a service is being developed for the purpose of bringing properly accredited inquirers into touch with existing sources of scientific, technical, and engineering information in the United States. A central office from which inquirers may be directed to Government bureaus and other places where much information of this character is already available has long been needed, and it is probable that the services of the research information committee, once well organized, will be in increasing demand.

In this same field of supplying information on scientific, technical, and engineering subjects, the work of the research council has already been developed in several different directions. For example, a subcommittee of the geology committee, consisting of one geologist and one highway engineer from each of 19 States extending from Maine to Texas, has collected a very large body of information regarding materials for rapid highway construction along the coast. The elaborate report of this committee, bound in seven volumes, with three atlases, has already been of considerable service, not merely from the standpoint of those interested in highway construction for possible military purposes, but also to the Shipping Board in connection with the problem of building concrete ships, for which the stone quarries described in the report are often adapted. In another field the work of the botanical raw products committee has supplied extensive data relating to raw products required by industries, especially in cases where imports have been affected by the war. In still another field the research council has been called upon to cooperate with the War College in supplying information relating to topographical, geographical, and related subjects. Without mentioning other cases in which the aid of the research council has been sought for the purpose of supplying technical information, it is clear that this function of its work, not only during the war but after its conclusion, is likely to undergo extensive development. Problems are constantly arising in scientific research and in the industries which have been already solved, though the solutions are buried in the extensive technical literature so effectually as to render them practically inaccessible, even to those having large libraries. In Germany this difficulty has been met by establishing similar centers of information regarding scientific and technical questions, through which the desired advice and assistance can be obtained.

ACTIVITIES OF COMMITTEES.

The chief activities during the past year of the various committees of the research council may be briefly stated as follows:

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Advisory committee on toxicity of preserved foods (J. J. Abel, chairman): Appointed to act in conjunction with Dr. Milton J. Rosenau, of the Harvard Medical School, who has undertaken an exhaustive study of the toxicity of preserved foods for the American Canners Association.

Aeronautics committee (W. F. Durand, chairman): The executive committee of the national advisory committee for aeronautics serves also as the aeronautics committee of the National Research Council, dealing with a great variety of aeronautical problems.

Agriculture committee (Raymond Pearl, chairman; Karl F. Kellerman, secretary): This committee, with the approval of the Secretary of Agriculture, is acting as the medium for arranging for cooperation, and as a clearing house for bringing together the men who are working on similar agricultural problems, but who have been in ignorance of the special phases that other investigators are studying. The problems selected for immediate consideration cover a wide range, including the systematic correlation of work on the conservation of breeding stock, the development of special experiments upon the economic use of protein in animal food, and the significance of proteins of different kinds and in different quantities.

Anatomy committee (H. H. Donaldson, chairman): Formed for the promotion of research in anatomy; at present acting in cooperation with the authropology committee on war problems.

Anthropology committee (W. H. Holmes, chairman; Charles B. Davenport, vice chairman; Ales Hrdlicka, secretary): Through the action of this committee, which will untimately devote its attention to research in anthropology, the minimum height requirement for the American Army was rendered from 5 feet 4 inches to 5 feet 1 inch (5 feet was recommended by the committee), thus obviating the discrimination against the taller native American which otherwise would have resulted from the effect of immigration of shorter European peoples. The committee has also dealt with other physical and hygienic requirements of recruits, the standardization of measurements, the collection of data and materials for scientific research, and the provision of information required by the Government on anthropological subjects.

Astronomy committee (E. C. Pickering, chairman; Henry Norris Russell, vice chairman): The first report of this committee on the larger research problems of astronomy has been published in the Proceedings of the National Academy of Sciences. Members of the committee have also made valuable suggestions regarding war problems and are taking part in their solution.

Botany committee (J. M. Coulter, chairman): The prime object of this committee is to promote research in botany. During the period of the war its members are devoting their attention to such

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research problems as the following: Dehydration of fruits and vegetables, sources of rubber, improvement of sugar beets, disease-resistant cereals, drought-resistant cereals, cultivation of native drug plants, substitutes for cotton in the manufacture of explosives, the food reserves in certain plants.

Botanical raw products committee (E. M. East, chairman): This special committee is collecting data for a botanical raw-products clearing house, to aid manufacturers needing raw products of a botanical nature, such as gums, oils, resins, fibers, wood, etc., to find either new geographical sources or new specific sources.

National census of research (S. W. Stratton, chairman): This committee has prepared an elaborate census of the research men and facilities of those institutions in the United States having important research departments. The institutions from which data have been obtained are included in the following classes: Government, State, and city bureaus, educational institutions, research foundations, industrial establishments, and commercial testing laboratories.

Chemistry committee (M. T. Bogert, chairman): The chemistry committee, through its various subcommittees, has worked in close touch with various bureaus of the Army and Navy and with the War Industries Board and other agencies of the Council of National Defense; it has aided in the solution of many problems directly or indirectly connected with the prosecution of the war.

Engineering committee (Gano Dunn, chairman; W. F. Durand, vice chairman, in charge of Washington office): The work of this committee, which has the active support of the great national engineering societies, is at present concentrated upon war problems such as the development of devices for the protection of ships from submarines, of protective body armor, and of airplanes and airplane engines. In the future, however, it will deal with all forms of research in engineering.

Foreign service committee (Joseph S. Ames, chairman): This committee made a trip to France and England soon after the outbreak of the war and obtained much important information on military and industrial questions from the French and British Governments and from men of science engaged in the solution of war problems. In return an allied French, British, and Italian scientific mission came to this country, the members of which have worked in active cooperation with the National Research Council and have supplied American officials with additional information concerning instruments and research methods in warfare.

Committee on gases used in warfare (Van. H. Manning, chairman): This special committee, which was organized by the military committee with the cooperation of various Government departments,

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inaugurated extensive research work on the problems of gas warfare, which is being continued under the direction of the Bureau of Mines.

Geography committee (W. M. Davis, chairman): Suspending for the present its plans for the promotion of geographical research, this committee has devoted its chief attention to special maps for military purposes (in cooperation with the Geological Survey), instructions for the use of topographic maps, handbooks on military areas, and physiographic features of the United States.

Geology committee (J. M. Clarke, chairman): The geology committee has issued a booklet stating briefly a plan of the service which a trained geologist could render in war operations and for the national defense. Subcommittees have been organized with the following scope: Camp sites, trenches and water supply, roads and road materials, and measurement of earth vibrations. The subcommittee on roads and road materials, of which the late Dr. W. B. Clark was the very efficient chairman, is engaged in the examination of every location of rock material suitable for quick highway and railway construction along the Atlantic and Gulf coasts. Large-scale maps have been prepared on which are plotted in detail all supplies of such materials, including commercial quarries, natural ledges, accumulations of field stone, stone walls, sand and gravel banks, all located with reference to transportation facilities. Plans are being made for similar work along the Mexican boundary and the Pacific coast.

Committee on industrial research (J. J. Carty, chairman): The purpose of this committee (which has now become the section on industrial research of the administrative division of the research council) is to promote a wider appreciation of the importance of industrial research on the part of the industrial organization, both large and small, that have not yet experienced its benefits. Important steps have already been taken which promise to accomplish the purpose in view.

Mathematics committee (E. H. Moore, chairman): The purpose of this committee is to advance research in all branches of pure and applied mathematics. During the period of the war the committee is encouraging mathematicians to undertake the solution of problems developed by military needs.

Committee on medicine and hygiene (Victor C. Vaughan, chairman: This committee, now incorporated in the new medical division of the council, has dealt with many medical research problems relating to the war. The military work already organized includes the preparation of antitoxins and serums for diphtheria, tetanus, pneumonia, dysentery, and meningitis; researches on an intradermal method of vaccinating for smallpox; polyvalent vaccines for typhoid fever; sterilization of drinking water. infected wounds; shock,

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fatigue; occupational diseases, with special reference to munition workers; protection of the ear from high explosives; and instruction of Army and Navy surgeons in the Carrel method of antiseptic surgery. Several subcommittees have been appointed to deal with special subjects, notably among which may be mentioned a subcommittee on psychiatry, which has been authorized to establish abroad a laboratory for the study of shell shock.

Military committee (C. D. Walcott, chairman; S. W. Stratton, vice chairman): The organization of this important committee has already been described. Through the assistance of its members a large number of military research problems have been formulated for investigation by various branches of the research council. As a means of securing cooperation between various bureaus of the Army and Navy the committee is of special value.

Committee on navigation and nautical instruments (L. A. Bauer, chairman): This committee, which was appointed at the request of the general munitions board, is cooperating with the Emergency Fleet Corporation in the preparation of specifications for ship watches, to take the place of chronometers whenever necessary; sextants, compasses, aneroid barometers, thermometers, hydrometers, marine glasses, and other nautical equipment required for the emergency fleet.

Optical glass committee (R. A. Millikan, chairman): The problem of securing the necessary supply of optical glass for military and other purposes has been attacked by this committee, working in cooperation with the general munitions board. The work in progress, through the cooperation of the Bureau of Standards, the geophysical laboratory of the Carnegie Institution, and several industrial corporations has resulted in meeting the pressing need for optical glass for military purposes.

Patent office committee (L. H. Baekeland, acting chairman): This committee was appointed at the request of the Commissioner of Patents, with the approval of the Secretary of the Interior, to investigate the procedure of the Patent Office.

Physics committee (R. A. Millikan, chairman; C. E. Mendenhall, vice chairman): The physics committee, which has worked in close touch with various bureaus of the Army and Navy, has hitherto devoted its attention exclusively to military problems, though it will ultimately promote physical research for scientific and industrial purposes. In cooperation with the French scientific mission, it has organized conferences of physicists on certain military problems and initiated many investigations for their solution.

Physiology committee (W. B. Cannon, chairman; W. H. Howell, vice chairman): This committee, which has worked in cooperation with the committee on medicine and hygiene, has organized a large

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number of investigations on physiological problems developed by the war. It will subsequently deal with physiological research in its broadest aspects.

Psychology committee (Robert M. Yerkes, chairman): The psychology committee has made extensive tests on methods for eliminating mental defectives and nervous types from the Army, the selection of recruits especially fitted for aviation and other difficult tasks, the development of apparatus for testing the skill of naval gunners, and other military problems. The work of the committee has proved so effective that it has led to the organization of a psychology division of the Surgeon General's Office, under the charge of Maj. Yerkes, which will apply psychological tests to all new recruits of the Army.

Committee on research in educational institutions (R. H. Chittenden, chairman): Through the action of this committee (which has now become a section of the administrative division of the council), 72 universities and colleges have established research committees to cooperate with the National Research Council. As a rule, these committees are composed of representatives of the board of trustees of the institution, of the faculty, and in some cases of the alumni. The purpose of these committees is to promote scientific research in educational institutions and cooperation with local industries in the development and application of research methods. The important steps already taken by some of these committees to improve conditions for research promise to be of great significance if generally adopted by educational institutions.

Submarine committee (Robert A. Millikan, chairman): This committee has been actively engaged, in cooperation with the Navy, in the solution of problems connected with submarine warfare.

Zoology committee (Edwin G. Conklin, chairman): This committee, appointed for the promotion of research in zoology, is now giving its attention to certain important problems developed by the war.

FINANCIAL SUPPORT.

Rapid progress was hindered for several months by the fact that the membership of the committees was widely scattered, while the very limited funds at the disposal of the council prohibited any considerable concentration of its work in Washington. Under such circumstances the results obtained by the various committees during this preliminary period may be regarded in most cases as satisfactory. It was recognized, however, that as soon as conditions might permit, an improved organization, concentrating the work in Washington in immediate contact with the various departments of the Government and securing the necessary coordination of the work of committees

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dealing with closely related subjects, would be essential. The realization of such a plan, however, necessarily depended upon the financial position of the council.

The appended statement indicates in detail the present resources of the council, including also those of the Science and Research Division of the Signal Corps, since the work of this division is carried on in such intimate relationship with other activities of the council that the two could not be separated without serious loss of efficiency. It will suffice at this point, therefore, to speak in general terms of the successive steps in the development of our financial resources. At the outset we were fortunate enough to secure the cooperation and support of the Engineering Foundation, which offered its funds, supplemented by special gifts from Mr. Ambrose Swasey and Mr. Edward D. Adams, to assist in meeting the needs of the research council, and provided it with an office in New York, together with the services of its secretary. Subsequently, Mr. Cleveland H. Dodge and Mr. Martin A. Ryerson contributed toward the support of the council, and special gifts to the chemistry, geology, and psychology committees did much to facilitate their work. The chief difficulties of the formative period were overcome, however, through a grant of $50,000 to the National Research Council, made payable through the president of the Carnegie Institution of Washington. In physics, particularly, the action of the Chief Signal Officer provided the means of developing the large number of physical devices required for the use of the Signal Corps, and also of equal value for other branches of the service. The connection of the council with the Army and Navy, through its military committee and also through the appointment of some of its members to military positions, has been of great value in establishing cross connections between bureaus interested in similar research problems, and in rendering available to both arms of the service devices developed through any special agency.

Thus the period marked by serious limitation of funds, felt in all phases of the council's work, is giving place to a new period, in which the work is progressing much more effectively. Like other bodies working during the first months of the war with the Council of National Defense, the research council provided its own funds and paid its own expenses. The nature of our work could not be expected to make a strong appeal until sufficient success had been attained to demonstrate its thoroughly practical value. Thus while special grants were made by both the War and Navy Departments to cover the expenses of various investigations organized by the research council, no general appropriation was obtained until January 7, 1918, when the President authorized a grant of $29,250 from his special fund, through the Council of National Defense, for the rental of the

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building at 1023 Sixteenth Street, now occupied by the research council, and for other miscellaneous expenses. The second important appropriation received through the Council of National Defense was the sum of $38,400, already mentioned in describing the work of the research information committee.

These cases illustrate how the work of the National Research Council has gradually gained the recognition and support of the Government. But in many instances grants from private funds are not only desirable, but essential to success. In certain bureaus of the Government ample funds are available for research. In other bureaus little or nothing has been provided for such purposes. But even when research funds are available, they can not ordinarily be appropriated until some specific device reaches a stage where its further development is clearly advisable. Thus the expenses of the international conference for the discussion of submarine problems, organized in June, 1917, were borne by the research council, and the necessary traveling expenses of several of the physicists who subsequently took part in the researches conducted in cooperation with the Navy were also met from our funds. As for the cost of these researches, this was borne in part by universities and other organizations, in part by the research council, and in part by the Navy Department, which has recently developed special laboratories and other facilities for this purpose, and provided large funds for its prosecution.

WAR ORGANIZATION.

As soon as the improved financial position of the council permitted, the following war organization of the council was undertaken, combining the work of its committees in various divisions, and concentrating its activities in Washington:

OFFICERS.

GEORGE E. HALE.....*Chairman*
CHARLES D. WALCOTT.....*First Vice Chairman*
GANO DUNN.....*Second Vice Chairman*
R. A. MILLIKAN.....*Third Vice Chairman*
JOHN JOHNSTON.....*Executive Secretary*
WHITMAN CROSS.....*Treasurer*
WALTER M. GILBERT.....*Assistant Secretary*
ALFRED D. FLINN.....*Assistant Secretary*

EXECUTIVE BOARD.

JOHN J. CARTY.....*Chairman*

Officers, chairmen and vice chairmen of divisions; the chairmen of sections of the administrative division; and 10 members at large.

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ADMINISTRATIVE DIVISION.

ARTHUR A. NOYES, *Chairman.*

Sections: FOREIGN RELATIONS, GEORGE E. HALE, *Chairman.*
GOVERNMENTAL RELATIONS, ———, *Chairman.*
STATE COUNCIL RELATIONS, JOHN C. MERRIAM, *Chairman.*
INDUSTRIAL RESEARCH, JOHN JOHNSTON, *Chairman.*
RESEARCH IN EDUCATIONAL INSTITUTIONS, JOHN C. MERRIAM, *Chairman.*
RESEARCH INFORMATION, ———, *Chairman.*

Committees included in the Administration Division:

1. RESEARCH INFORMATION COMMITTEE—
   Washington: S. W. STRATTON, *Chairman;* Chief of Naval Intelligence Service; Chief of Army Intelligence Service; GRAHAM EDGAR, *Technical Assistant;* W. M. GILBERT, *Secretary.*
   Paris: W. F. DURAND, Representing National Research Council; Representative of Naval Intelligence Service; Representative of Army Intelligence Service; K. T. COMPTON, *Technical Assistant;* Lieut. TOD FORD, *Assistant.*
   London: H. A. BUMSTEAD, Representing National Research Council; Representative of Naval Intelligence Service; Representative of Army Intelligence Service; S. W. FARNSWORTH, *Technical Assistant.*
2. COMMITTEE ON CENSUS OF RESEARCH, S. W. STRATTON, *Chairman.*
3. PATENT OFFICE COMMITTEE, L. H. BAEKELAND, *Acting Chairman.*

MILITARY DIVISION.

CHARLES D. WALCOTT, *Chairman* (Secretary, Smithsonian Institution).
S. W. STRATTON, *Vice Chairman* (Director, United States Bureau of Standards).
CARL L. ALSBERG, Chief, Bureau of Chemistry, United States Department of Agriculture.
Admiral WILLIAM S. BENSON, Chief of Naval Operations, United States Navy.
Maj. Gen. WILLIAM S. BLACK, Chief of Engineers, United States Army.
HOWARD E. COFFIN, member of advisory commission, Council of National Defense.
Maj. Gen. WILLIAM CROZIER, Chief of Ordnance, United States Army.
Rear Admiral RALPH EARLE, Chief, Bureau of Ordnance, United States Navy.
WALTER S. GIFFORD, Director, Council of National Defense.
Maj. Gen. WILLIAM C. GORGAS, Surgeon General, United States Army.
Rear Admiral ROBERT S. GRIFFIN, Engineer in Chief, United States Navy.
Brig. Gen. P. D. LOCKRIDGE, President, Army War College, United States Army.
VAN H. MANNING, Director, United States Bureau of Mines.
CHARLES F. MARVIN, Chief, United States Weather Bureau.
GEORGE O. SMITH, Director, United States Geological Survey.
Maj. Gen. GEORGE O. SQUIER, Chief Signal Officer, United States Army.
Rear Admiral DAVID W. TAYLOR, Chief Constructor, United States Navy.
Col. RALPH H. VAN DEMAN, Chief of Military Intelligence Section, United States Army.
Capt. ROGER WELLES, Director of Naval Intelligence, United States Navy.

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DIVISION OF ENGINEERING.

HENRY M. HOWE, *Chairman.*

SECTION OF AERONAUTICS, WILLIAM F. DURAND, *Chairman.*
SECTION OF METALLURGY, HENRY M. HOWE, *Chairman.*
SECTION OF MECHANICAL ENGINEERING, S. L. G. KNOX, *Chairman.*

Other sections are in process of organization.

Committees included in the engineering division: 1. Engineering committee, GANO DUNN, *Chairman.* (*a*) Subcommittee on protective body armor, BASHFORD DEAN, *Chairman.*

DIVISION OF PHYSICS, MATHEMATICS, ASTRONOMY, AND GEOPHYSICS.

(SEE P. —, SCIENCE AND RESEARCH DIVISION, UNITED STATES SIGNAL CORPS.)

R. A. MILLIKAN, *Chairman.*
C. E. MENDENHALL, *Vice Chairman.*

Committees included in physics division:

1. PHYSICS COMMITTEE, R. A. MILLIKAN, *Chairman*—
   Subcommittees: SUBMARINE INVESTIGATIONS (nine groups).
   WIRELESS.
   LOCATION OF INVISIBLE AIRCRAFT.
   LOCATION OF MINING AND TUNNELING OPERATIONS.
   MUZZLE VELOCITY OF PROJECTILES.
   NAVAL RANGE FINDERS.
   RANGE FINDERS FOR ANTIAIRCRAFT SERVICE.
   STATIC CHARGES ON AIRSHIPS.
   SUBMARINE MINES.
   USE OF HIGH PRESSURE IN MANUFACTURE OF GUNS.
   VISIBILITY.
   MONOCULARS AND BINOCULARS.
   CAMOUFLAGE and others.
2. MATHEMATICS COMMITTEE, E. H. MOORE, *Chairman.*
3. ASTRONOMY COMMITTEE, E. C. PICKERING, *Chairman;* H. N. RUSSELL, *Vice Chairman.*
4. COMMITTEE ON OPTICAL GLASS, R. A. MILLIKAN, *Chairman.*
5. COMMITTEE ON NAVIGATION AND NAUTICAL INSTRUMENTS, L. A. BAUER, *Chairman.*

DIVISION OF CHEMISTRY AND CHEMICAL TECHNOLOGY.

JOHN JOHNSTON, *Chairman.*
W. H. WALKER, *Vice Chairman.*

Committees included in the chemistry division:

1. CHEMISTRY COMMITTEE, JOHN JOHNSTON, *Chairman*—
   Subcommittees: ANALYTICAL CHEMISTRY, WILLIAM F. HILLEBRAND, *Chairman.*
   CHEMICAL APPARATUS, ARTHUR H. THOMAS, *Chairman.*
   BIOCHEMISTRY, FRANK P. UNDERHILL, *Chairman.*

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CARBOHYDRATE CHEMISTRY, CLAUDE S. HUDSON. *Chairman.*

CHEMISTRY OF CELLULOSE AND PAPER, ARTHUR D. LITTLE, *Chairman.*

CHEMISTRY OF CEMENTS AND RELATED BUILDING MATERIALS, PREVOST HUBBARD, *Chairman.*

CHEMISTRY OF CERAMICS, EDWARD W. WASHBURN, *Chairman.*

CHEMISTRY OF DYESTUFFS AND TEXTILES, JOSEPH M. MATHEWS, *Chairman.*

ELECTROCHEMISTRY, WILDER D. BANCROFT, *Chairman.*

CHEMISTRY OF EXPLOSIVES, ARTHUR M. COMEY. *Chairman.*

CHEMISTRY OF FATS, FATTY OILS, AND SOAPS, MARTIN H. ITTNER, *Chairman;* DAVID WESSON, *Vice Chairman.*

CHEMISTRY OF FERMENTATION AND FERMENTATION PRODUCTS, JOHN H. LONG, *Chairman.*

FOOD CHEMISTRY, CARL L. ALSBERG, *Chairman.*

FOREST PRODUCTS, JOHN E. TEEPLE, *Chairman.*

CHEMISTRY OF FUELS, RAYMOND F. BACON, *Chairman.*

GASES USED IN WARFARE, GEORGE A. BURRELL, *Chairman.*

CHEMISTRY OF GLASS, ARTHUR L. DAY, *Chairman.*

CHEMISTRY OF GLUE AND OTHER COLLOIDS, JEROME ALEXANDER, *Chairman.*

INORGANIC CHEMISTRY, WILLIAM C. BRAY. *Chairman.*

CHEMISTRY OF LEATHER AND TANNING, ALLEN ROGERS, *Chairman.*

METALLURGICAL CHEMISTRY, JOSEPH W. RICHARDS, *Chairman.*

MINERALOGICAL AND GEOLOGICAL CHEMISTRY, FRANK W. CLARKE, *Chairman.*

NITRATES AND AMMONIA, ARTHUR A. NOYES, *Chairman.*

ORGANIC CHEMISTRY, WILLIAM A. NOYES, *Chairman.*

CHEMISTRY OF PAINTS, VARNISHES, AND RESINS. HENRY A. GARDNER, *Chairman.*

PHARMACEUTICAL CHEMISTRY, FREDERICK B. POWER, *Chairman.*

PHYSICAL CHEMISTRY, ARTHUR B. LAMB, *Chairman.*

PLATINUM AND RELATED METALS, JAMES LEWIS HOWE, *Chairman.*

PRIMERS, RICHARD C. TOLMAN, *Chairman.*

CHEMISTRY OF RUBBER AND ALLIED SUBSTANCES, DAVID SPENCE, *Chairman.*

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CHEMISTRY OF SOILS AND FERTILIZERS, HOMER J. WHEELER, *Chairman.*

CHEMISTRY OF SYNTHETIC DRUGS, JULIUS STIEGLITZ, *Chairman.*

TEXTILE COATINGS, EDWARD C. WORDEN, *Chairman.*

CHEMICAL ENGINEERING, CHARLES F. MCKENNA, *Chairman.*

2. COMMITTEE ON GASES USED IN WARFARE, VAN. H. MANNING, *Chairman.*

DIVISION OF GEOLOGY AND GEOGRAPHY.

JOHN C. MERRIAM, *Chairman.*
WHITMAN CROSS, *Vice Chairman.*

Committees included in division of geology and geography:

1. GEOLOGY COMMITTEE, JOHN M. CLARKE, *Chairman*—
   PACIFIC COAST SUBCOMMITTEE ON GEOLOGY, J. C. MERRIAM, *Chairman.*
   Subcommittees: MATERIALS FOR RAPID HIGHWAY CONSTRUCTION, EDWARD B. MATHEWS, *Chairman.*
   WATER SUPPLY FOR CAMPS, R. A. F. PENROSE, *Chairman.*
   MEASUREMENTS OF EARTH VIBRATIONS, J. B. WOODWORTH, *Chairman.*
   GEOLOGY OF CANTONMENTS AND TOPOGRAPHICAL INSTRUCTION IN TRAINING CAMPS, FRANK W. DE WOLF, *Chairman.*
2. GEOGRAPHY COMMITTEE, W. M. DAVIS, *Chairman.*

DIVISION OF MEDICINE AND RELATED SCIENCES.

R. M. PEARCE, *Chairman.*
ROBERT M. YERKES, *Vice Chairman.*

Committees included in medical division:

1. ANATOMY COMMITTEE, H. H. DONALDSON, *Chairman.*
2. PHYSIOLOGY COMMITTEE, W. B. CANNON, *Chairman;* W. H. HOWELL, *Vice Chairman*—
   SUBCOMMITTEE FOR INVESTIGATIONS ON THE PHYSIOLOGY OF SHOCK, W. B. CANNON, *Chairman.*
   Subcommittees: CONTROL OF HEMORRHAGE, W. H. HOWELL, *Chairman.*
   SOLUTIONS ADAPTED FOR TRANSFUSION AFTER HEMORRHAGE, L. J. HENDERSON, *Chairman.*
   MUSCULAR WORK AND FATIGUE, FREDERICK S. LEE, *Chairman.*
3. COMMITTEE ON MEDICINE AND HYGIENE, VICTOR C. VAUGHAN, *Chairman*—
   SUBCOMMITTEE ON PSYCHIATRY, STEWART PATON, *Chairman.*
4. PSYCHOLOGY COMMITTEE, ROBERT M. YERKES, *Chairman;* JOHN W. BAIRD, *Vice Chairman.*
   Subcommittees: METHODS FOR THE PSYCHOLOGICAL EXAMINATION OF RECRUITS, ROBERT M. YERKES, *Chairman.*
   TESTS OF SPECIAL SKILL, EDWARD L. THORNDIKE, *Chairman.*

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PROBLEMS OF AVIATION, INCLUDING THE EXAMINATION OF AVIATION RECRUITS, EDWARD L. THORNDIKE, *Secretary.*

INCAPACITY, REEDUCATION, AND VOCATIONAL TRAINING, SHEPHERD I. FRANZ, *Chairman.*

VISUAL PROBLEMS, RAYMOND DODGE, *Chairman.*

PROBLEMS OF MILITARY TRAINING AND DISCIPLINE, WILLIAM C. BAGLEY, *Chairman*

5. ANTHROPOLOGY COMMITTEE, CHARLES B. DAVENPORT, *Chairman;* ———, *Vice Chairman;* ALES HRDLICKA, *Secretary.*
6. COMMITTEE ON MEDICAL ZOOLOGY, WITH GROUPS REPRESENTING—
   (*a*) ENTOMOLOGY.
   (*b*) HELMINTHOLOGY.
   (*c*) PROTOZOOLOGY.
7. ADVISORY COMMITTEE ON TOXICITY OF PRESERVED FOODS, J. J. ABEL, *Chairman.*

DIVISION OF AGRICULTURE, BOTANY, FORESTRY, FISHERIES, AND ZOOLOGY.

VERNON L. KELLOGG, *Chairman.*

Committees included in division of agriculture and related subjects:

1. AGRICULTURE COMMITTEE, KARL F. KELLERMAN, *Secretary.*
2. BOTANY COMMITTEE, JOHN M. COULTER, *Chairman.*
3. BOTANICAL RAW-PRODUCTS COMMITTEE, E. M. EAST, *Chairman.*
4. ZOOLOGY COMMITTEE, C. E. MCCLUNG, *Representative.*

FUNCTIONS OF DIVISIONS.

It is impossible within the limits of this report to give a detailed account of the work of the various divisions and of the committees grouped under them. Reports of the meetings of the executive board of the council have been published in the Proceedings of the National Academy of Sciences, where many of the committees have also published reports. In order to give an intelligent idea of the present status and activities of the council, however, it will be necessary to speak briefly of the plan of organization and of the work of the various divisions.

EXECUTIVE BOARD.

The executive board of the war organization takes the place of the former executive committee of the council. It is constituted of the chairmen and vice chairmen of the various divisions, the chairmen of the sections of the administrative division, together with several members at large. The executive board meets monthly and transacts the general business of the council. In order to secure prompt action when needed, however, a smaller committee has been authorized to act when necessary, subject to the approval of the executive board.

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ADMINISTRATIVE DIVISION.

The administrative division consists of five sections dealing with the various relations of the council, and also includes the work of the research information committee. The section which is to be devoted to the promotion of industrial research is at present under organization. This is certain to prove one of the most valuable branches of the council's work, as it will be called upon to assist in securing the widest possible appreciation of the necessity of introducing scientific research on a large scale into the industries. The British advisory council for scientific and industrial research has been especially active in this field, and has already secured results which will greatly strengthen some of the larger industries of the British Empire.

At the request of the Commissioner of Patents, and with the approval of the Secretary of the Interior, the National Research Council has organized a committee to investigate and report upon the work of the Patent Office in the hope of finding means of improving the present procedure. The work of this committee will be done in connection with the other activities of the administrative division.

The establishment of research committees in connection with several of the State councils of defense, and the necessity of securing suitable cooperation between these committees and the National Research Council, has led to the formation of an important section of the administrative division. The chairman of this division, who has had extensive experience as chairman of the research committee of the California State Council of Defense, prepared the following report, which has been adopted as expressing the attitude of the National Research Council toward the work of State research committees:

"It is the opinion of your committee that the greater part of the problem work of the National Research Council can be handled most satisfactorily through the special committees or divisions established for research in specific fields of investigation. To a limited extent phases of these investigations of problems may be turned over to adequately organized and supported research groups in different parts of the country, some of these groups representing educational or research institutions and others being organized under the auspices of State governments or State councils of defense.

"As numerous important problems of research relate to the development of natural resources, industries, consideration of health conditions, and other problems of a local nature, it seems desirable in many cases to have an organization of research interests related to the State, and if possible supported by it. Such organizations might,

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under existing conditions, be best cared for as committees under the State councils of defense.

"It is desirable to have the National Research Council so related to the State research scientific committees that the results of their investigations may become quickly available to the central office of the council, and that the needs of the council for work of a local character may be met by the State committees.

"Your committee respectfully suggests the following definition of function, organization, and relations of State research committees:

Function of State Research Committees.—"Problems involving local needs in development of natural resources, local industries, health conditions, or any matters to which science may lend its aid.

"Problems involving local materials, industries, laboratories, or talent, development or use of which would contribute to the good of the Nation as a whole or in part regardless of questions of needs of the State in which the investigation originates.

Organization of State Committees.—"In intial organization the State committee should be small but widely representative of fields of research. Additions to membership should be made as the development of actual research progresses. The committees should, at the outset, include members of State boards covering work in which scientific research plays an important part and representatives of scientific organizations or institutions at which significant research is in progress, especially institutions in which research committees are organized.

"State research committees should at this time be organized as subdivisions of State councils of defense, where such councils exist.

"Financial support of State committees should come from State funds received by way of the State councils of defense, or from other special funds. It is in all cases desirable to have secretarial organization permitting full correspondence on all matters relating to the committee.

Relation of Research Council to State Committees.—"It is desirable to have the State research committees affiliated with the National Research Council; the results of work of these committees should be reported to the State council of defense and to the National Research Council by way of either or both of these bodies; results obtained by the State research committees should go to the Council of National Defense when needed."

The research council is already working in active cooperation with several State research committees, and information is being supplied to various State councils of defense which have asked for suggestions regarding research.

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The work of the committee on research in educational institutions has already been described. The functions of this committee will be extended and developed through the administrative division of the council.

MILITARY DIVISION.

The constitution of the former military committee of the council is explained above. In the war organization this committee becomes the military division of the council. Under it various extensions of the present work will be organized.

ENGINEERING DIVISION.

In the case of engineering, the council has been acting hitherto through its committees on engineering and aeronautics, both of which will be incorporated in the new division of engineering. The various sections of the engineering divisions are now under organization. One of the most important of these sections is that of metallurgy, the organization of which is nearly complete. The section of design of the science and research division of the United States Signal Corps will also work in close cooperation with the division of engineering and essentially as one of its sections. Other sections of the division are now in process of formation.

DIVISION OF PHYSICS.

The work of the committees of physics, mathematics, astronomy, optical glass, and navigation and nautical instruments is now concentrated in the division of physics and related sciences, which also comprises the work of the Science and Research Division of the United States Signal Corps. The character of the work conducted by this division of the Signal Corps is indicated by the following outline of its various activities:

Lieut. Col. R. A. Millikan, officer in charge of activities in Washington, D. C.

I. Aeronautics instrument section, Maj. C. E. Mendenhall.

(*a*) Expert testing of lenses, First Lieut. A. K. Chapman (laboratory, Kodak Park, Rochester, N. Y., in charge of Mr. F. M. Bishop).

(*b*) Specification, design, and development of photographic apparatus and methods of mounting cameras in airplanes, Capt. H. E. Ives.

(*c*) Computation and other development work in connection with airplane bombs and bomb sights, Prof. Wilmer A. Duff.

(*d*) Technical consultation in connection with development of oxygen apparatus, Dr. E. J. Eyster.

II. Signaling section, Pvt. A. J. Dempster. Development of new signaling devices.

III. Design section, Mr. S. L. G. Knox. A new type of airplane gun is being developed and designed with the aid of an appropriation from the Board of Ordnance and Fortifications.

46517—S. Doc. 192, 65-2——5

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Activities abroad.—Second Lieut. Leonard B. Loeb, Signal Reserve Corps. A. S. Laboratoire de l'Intérieur, Paris; First Lieut. Tod Ford, jr., liaison officer, headquarters A. E. F.

IV. Meteorological section:

Activities abroad.—Maj. Edward H. Bowie, headquarters A. E. F. Officers and enlisted men have been ordered abroad for meteorological work in connection with American expeditionary force.

Activities in the United States.—Lieut. B. J. Sherry, United States Weather Bureau, Washington, D. C.

Meteorological stations have been opened at the following points in the United States: Fort Leavenworth, Kans., Pvt. Eckley Ellison; Langley Field, Va., Pvt. Allan E. Waterman; Camp Devens, Mass., Pvt. H. R. Grenrich; Fort Screven, Ga., Pvt. Roy J. Rogers; Fort Snelling, Minn., Pvt. P. E. Johnson.

The following aerological stations have been opened: Sandy Hook, N. J., Second Lieut. John W. Howard; Fort Omaha, Nebr., Pvt. William E. Bowen.

V. Other activities under science and research division in the United States:

Baltimore, Md., Johns Hopkins University, Maj. R. W. Wood. New methods of various kinds; devices for preventing airplanes catching fire, etc.

New London, Conn., signaling experiments in charge of Pvt. Arthur J. Dempster, care of Naval Experiment Station.

Langley Field, Va., Signal Corps research laboratory, Pvt. A. H. Nietz.

As for the other work of the division of physics and the related sciences, its nature is sufficiently illustrated by the list of subcommittees given in the plan of war organization.

DIVISION OF MEDICINE AND RELATED SCIENCES.

The division of medicine and the related sciences has been organized with special reference to military needs. The committees of the research council grouped under this division are those which are directly related to experimental medicine or to subjects also dealt with under the Surgeon General's office. The chief purposes of the division are:

1. To cooperate closely with the Surgeon General of the Army (through Col. Russell) and of the Navy (through Dr. Stitt) in determining urgent problems and to enlist the aid of civilian laboratories in the solution of these problems.

2. To assist the Surgeon Generals of the Army and Navy in procuring trained investigators to enter the respective services as contract surgeons to undertake special field investigations during short periods of time.

3. To send, if it is considered advisable, commissions or individuals abroad, to determine the urgent problems which should be taken up without loss of time in civilian laboratories in this country.

4. To invite, if it is considered necessary, commissions or individuals from foreign countries to this country to advise with the medical division of the National Research Council.

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5. To maintain correspondence with prominent medical investigators in the American Expeditionary Forces and in civilian laboratories in France, England, and Italy, and thus obtain reports of the important fields of research, the character of the work in progress, and the needs of the workers.

6. To establish relations with, and, if agreeable to them, to cooperate with research organizations abroad, as (*a*) British medical research committee, (*b*) the research society recently organized in France by medical officers of American, French, and British forces, and (*c*) the committee on medical research of the American Red Cross in France, etc.

7. To obtain reports of all medical research organizations in this country dealing with war problems and of individuals engaged in the investigation of war problems.

8. To maintain a bureau for the dissemination of up-to-date bibliographies of all forms of medical research bearing on war problems.

9. (*a*) To prepare lists of individuals and laboratories equipped and ready to undertake research at short notice. (*b*) To prepare lists of individuals who will hold themselves in readiness to work for shorter or longer periods on special or emergency problems or to augment existing laboratory staffs in a group of selected laboratories, such as the Rockefeller, Sprague, and Hooper Institutes and research departments of certain universities.

10. To hold conferences from time to time in Washington or other central city for discussion of important research problems and methods of attack.

11. To hold military medical meetings from time to time in the neighborhood of large cantonments for the discussion of medical problems by military and civilian physicians.

DIVISION OF CHEMISTRY AND CHEMICAL TECHNOLOGY.

The chemical work of the council has been reorganized and is now in the hands of a division of chemistry and chemical technology, the purpose of which is to secure effective cooperation in the investigation and solution of the many pressing problems involving chemistry and chemical engineering which have been raised by the war. These problems are so multifarious that they can not be readily summarized or tabulated, but the following general statements may serve to illustrate the work of the division. Its chief purposes are:

1. To ascertain the most urgent problems arising out of the various war activities of the Government, and to place these problems before men qualified to solve them.

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2. To enlist the support of the chemists and chemical technologists, and to keep as fully informed as possible about their training and qualifications so as to aid the Government in the selection of competent men in chemical work here or abroad.

3. To aid in the interchange of information with our allies; to keep in touch with all chemical research work now going on in this country and to keep informed upon the chemical equipment available at the various institutions and industrial plants where such work could be carried on.

4. To cooperate with manufacturers in an endeavor to utilize waste and by-products, to devise acceptable substitutes for raw materials which are scarce or urgently needed for other purposes, to promote the manufacture of wholly new substances (for example, for gas warfare), and to insure that the equipment in men and material may be used to the best advantage.

5. To point out the advisability of having new and up-to-date advanced textbooks and reference works in chemistry in English, and to work toward securing a better appreciation and a more intelligent support of chemistry on the part of the community.

6. To hold conferences in Washington or elsewhere for the discussion of important research problems, or of ways and means of making the work of the division more effective.

DIVISION OF GEOLOGY AND GEOGRAPHY.

The division of geology and geography has prepared a plan for utilizing the large amount of preparatory work which has been accomplished by the committees on geology and geography with a view to adapting the work of the division most directly to the problems of the war. It is hoped that closer touch with departments of the Government connected with war work will serve to increase the effectiveness of both committees.

The division is collating the data contained in replies to questionnaires sent out by Government bureaus and geological and techincal societies, in order to bring into one list the essential facts as to the geologists and geographers of the country with regard to the nature and conditions of service that can best be rendered by them in the war, and the researches they are conducting which bear on war problems.

The resources of the division have been especially placed at the disposal of the intelligence section of the War College for the assembling of any information which it may require.

DIVISION OF AGRICULTURE, BOTANY, ZOOLOGY, FORESTRY, AND FISHERIES.

The division of agriculture, botany, zoology, forestry, and fisheries is now in process of organization. Its functions will be analogous to

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those of the medical division, and it is hoped that it may secure the necessary coordination of researches in the field it occupies.

FUTURE OF THE NATIONAL RESEARCH COUNCIL.

The results already accomplished by the National Research Council and the increasing requests for its assistance seem to leave no doubt as to the need for a centralizing body of this character. A plan of permanent organization, adapted for the conditions existing after the war, is being carefully studied. The organization of the research council under the charter of the National Academy of Sciences is undoubtedly sound. It provides the necessary connection with the Government and eliminates all political influences from the appointment of its members. The inclusion of the heads of Government bureaus devoting special attention to research and the plan of securing their appointment by the President on the nomination of the National Academy provides for the first time a means of effecting necessary cooperation between these bureaus, which have developed to great proportions and have at their disposal large sums for scientific research. Other elements in the permanent scheme of organization must be such as to assure the close cooperation of all research agencies in the country and of the chief national scientific, technical, and engineering societies interested in research. The widespread cooperation already secured and the experience gained in connection with the war will afford a useful guide for the development of a sound and effective plan.

GEORGE E. HALE, *Chairman.*

STATEMENT OF CONTRIBUTIONS AND APPROPRIATIONS FOR THE WORK OF THE NATIONAL RESEARCH COUNCIL FROM SEPT. 1, 1916, TO MAR. 1, 1918, (18 MONTHS).

I. Cash donated to the council on account of general expenses of office, maintenance, and special investigations:		
A. Engineering Foundation:		
1. Services of secretary	$5,000.00	
2. Expenses of committees	510.00	
3. Office and traveling expenses	3,526.09	
		$9,036.09
B. George S. Isham		50.00
C. Martin A. Ryerson		1,000.00
D. Anonymous		100.00
E. Cleveland H. Dodge		5,000.00
F. Clarence H. Mackay, for expenses connected with work of subcommittee on protective body armor		1,000.00
G. Carnegie Corporation of New York		50,000.00
H. Rockefeller Foundation, for Division of Medicine and Related Sciences		50,000.00

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I. Special contributions for work of psychology committee		$4,100.00
J. Special contributions for work of chemistry committee		4,614.05
K. Special contributions for work of geology committee		800.00
		74,700.14
II. Governmental appropriations available for work under immediate direction of research council:		
A. President's emergency appropriation (available through the Council of National Defense):		
1. General office expenses of research council		29,250.00
B. Council of National Defense:		
1. Appropriation for agriculture committee	$3,000.00	
2. Appropriation for research information committee	38,400.00	
		41,400.00
C. War Department, Ordnance Bureau:		
1. Special appropriation for development of new type of gun by research council	15,000.00	
		15,000.00
		160,350.14
III. Governmental appropriation for work organized in connection with the national research council (estimated):		
A. United States Signal Corps, for work of Science and Research Division:		
1. Personnel	$45,000.00	
2. Equipment and supplies	65,000.00	
		110,000.00
		270,350.14

Many other appropriations have been made by Government bureaus, educational institutions, and private research laboratories for investigations which have been conducted more or less directly in cooperation with the research council. The total amount of such contributions for research work can not be closely estimated.

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ANNUAL REPORT OF THE TREASURER.

JANUARY 1 TO DECEMBER 31, 1917.

To the PRESIDENT OF THE NATIONAL ACADEMY OF SCIENCES:

I have the honor to submit the following report as treasurer, for the fiscal year January 1, to December 31, 1917. Some of the items of general interest will be mentioned before presenting details.

The volume of financial transactions, apart from investments, is indicated by the statement that the income of the academy from dues, interest on investments, subscriptions to the Proceedings, contributions to Proceedings fund, and the William Ellery Hale lectureship was $17,092.44, while the miscellaneous disbursements amounted to $9,567.65 and payments on grants from trust funds and for medals were $6,569.12.

The sum of investments held by the academy on December 31 was $248,623.50, yielding on that date at the rate of 5.01 per cent.

Changes in investments may be summarized as follows: Loans on real estate aggregating $15,000 were paid and loans amounting to $18,000 were renewed at increased rates of interest; bonds of the face value of $26,500 were purchased for $25,618.75.

In accordance with the action of the academy in November, 1916, the capital of the Marsh fund was increased to $18,500 through the addition to it of interest on the deferred payments of the bequest from Prof. O. C. Marsh, received in 1916, and by transfer of accumulated income. By the addition of further increments of $500 annually from income this fund will, on February 1, 1920, reach the total of $20,000 authorized by the academy.

A first payment of $2,500 was received from the executors of the estate of Mrs. Mary Anna Palmer Draper toward the total of $25,000 bequeathed to the academy by Mrs. Draper in 1915 to establish the Billings fund.

The sum of $1,068.52 was added to the Comstock fund from accumulated income on November 20, 1917, in accordance with the directions of the donor.

The sum of $6,487.20 was received toward defraying expenses of the National Research Council and $4,147.85 was expended for that purpose.

The consolidated investment fund reached a total of $176,745.50 by the addition during the year of the Murray and Billings funds and the increase of the Marsh fund.

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TRUST FUNDS OF THE ACADEMY.

The trust funds of the academy, the income of which is administered for specific purposes, are enumerated below. The capital of certain funds has been increased beyond the amount of the original gift or bequest, by the transfer of accumulated income, at the request of the donors or by action of the academy.

Bache fund: Bequest of Alexander Dallas Bache, a member of the academy, 1870. To aid researches in physical and natural sciences $56,000.00

Watson fund: Bequest of James C. Watson, a member of the academy, 1874. For the promotion of astronomical science through the award of the Watson gold medal and grants of money in aid of research 25,000.00

Draper fund: Gift of Mrs. Henry Draper, 1883, in memory of her husband, a former member of the academy. To found the Henry Draper gold medal, to be awarded for notable investigations in astronomical physics. The balance of income is applied to aid research in the same science 10,000.00

Smith fund: Gift of Mrs. J. Lawrence Smith, 1884, in memory of her husband, a former member of the academy. To found the J. Lawrence Smith gold medal, to be awarded for important investigations of meteoric bodies and to assist, by grants of money, researches concerning such objects 10,000.00

Gibbs fund: Established by a gift of Wolcott Gibbs, a member of the academy, 1892, and increased by a bequest of the late Morris Loeb, 1914. For the promotion of researches in chemistry 5,545.50

Gould fund: Gift of Miss Alice Bache Gould, 1897, in memory of her father, a former member of the academy. For the promotion of researches in astronomy 20,000.00

Comstock fund: Gift of Gen. Cyrus B. Comstock, a member of the academy, 1907. To promote researches in electricity, magnetism, or radiant energy, through the Comstock prize, of money, to be awarded once in five years for notable investigations. The fund is to be increased ultimately to $15,000 ..... 12,406.02

Marsh fund: Bequest of Othniel Charles Marsh, a member of the academy, 1909. To promote original research in the natural sciences. To the original bequest of $10,000 the academy has added interest received from the estate and authorized the increase of the fund to $20,000 by annual additions from income 18,500.00

Murray fund: A gift from Sir John Murray, 1911, to found the Alexander Agassiz gold medal, in honor of a former member and president of the academy, to be awarded for original contributions to the science of oceanography 6,000.00

Hartley fund: A gift from Mrs. Helen Hartley Jenkins, 1913–14, in memory of her father, Marcellus Hartley, to found the medal of the academy awarded for eminence in the application of science to the public welfare 1,200.00

Billings fund: Established by the bequest of Mrs. Mary Anna Palmer Draper (Mrs. Henry Draper), of $25,000, 1915. To support the publication of the Proceedings of the academy or for other purposes to be determined by the academy. First installment 2,500.00

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Elliot fund: Gift of Margaret Henderson Elliot to found the Daniel Giraud Elliot gold medal and honorarium, for the most meritorious work in zoology or paleontology published in each year.. $8,000.00

In addition to the above-named trust funds the academy holds the following:

Agassiz fund: Bequest of Alexander Agassiz, a member of the academy, 1910, for the general uses of the academy..... $50,000.00

Building fund: A gift from Alexander Agassiz and Theodore N. Gill, former members of the academy, toward a building for the academy, together with accumulated income..... 9,000.00

STATEMENTS OF ASSETS AND LIABILITIES, DECEMBER 31, 1917.

ASSETS.

1. Mortgage notes, secured by first mortgages on real estate.....		$85,750.00
2. Bonds, giving name, face value, rate of interest, and cost:		
4 American Telephone & Telegraph Co., collateral fives, due Dec. 1, 1946. 4 at $1,000. Nos. 640, 29245, 29246, 41419.....	$3,817.50	
5 Asheville Power & Light Co., first mortgage 30-year gold, 5 per cent, due Apr. 1, 1942, New York. 5 at $1,000. Nos. 272, 490, 492, 508, 509.....	4,892.50	
12 Broadway Realty Co., first 5 per cent gold, due Sept. 1, 1926. 12 at $1,000 face value. Nos. 38, 50, 796, 963–5, 1068, 1616–20. Purchase money..	12,345.00	
10 Bush Terminal Buildings Co., first mortgage, 50-year sinking fund, 5 per cent gold bonds, due Apr. 1, 1960. 10 at $1,000 face value. Nos. 1383–7 and 2805–9.....	9,375.00	
5 Chesapeake & Ohio, general mortgage, 4.5's gold bonds, due New York, Mar. 1, 1992. 5 at $1,000. Nos. 15350, 15351, 15352, 15353, 15354.....	4,600.00	
4 City of Tacoma, Green River special water fund No. 2, 5 per cent, due Oct. 1, 1939. 4 at $1,000. Nos. 1508, 1509, 1510, 1511.....	4,140.00	
12 Cleveland Electric & Illuminating Co., first mortgage, 5 per cent gold bonds, due New York, Apr. 1, 1939. 4 at $500 and 8 at $1,000. Nos. M6060, M6069, M6097, M15094–15098, D261, D262, D263, D264.....	9,597.50	
19 Cosmos Club, 4.5 per cent bonds, due July 1, 1949. 19 at $1,000. Nos. 286–297, 299, 301–305, 350.....	19,000.00	
7 Detroit Edison Co., 5's, first mortgage, 30-year, gold, due Jan. 1, 1933. 7 at $1,000. Nos. 557, 2442, 2443, 3024, 3252, 3253, 8086.....	7,177.50	
5 Dominion Coal Co. (Ltd.), first mortgage, sinking-fund gold bonds, 5 per cent, due New York, May 1, 1940. 5 at $1,000. Nos. A1036–A1040..	4,675.00	

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8	Galveston, Harrisburg and San Antonio, Mexican & Pacific Ex., second guaranteed 5's, due Jan. 1, 1931. 8 at $1,000. Nos. 1044, 1048, 1248, 2112–2116	$8,030.00
2	Georgia Ry. & Electric Co., first consolidated mortgage, 5's, sinking-fund gold, due Jan. 1, 1932. 2 at $1,000. Nos. 1061, 1600	2,055.00
13	Government of the Province of Alberta 4.5 per cent, 10-year gold debenture, due New York, Feb. 1, 1924. 11 at $100; Nos. 1501–1511. 2 at $500; Nos. 2031, 2032, $2,100	2,008.50
6	Government of the Province of Alberta, 5 per cent, 10-year gold debenture, due New York, May 1, 1925. 1 at $1,000; No. 2364. 5 at $500. Nos. B189–B193. $3,500	8,373.75
1	Government of the Province of Alberta, 4.5 per cent, 10-year gold debenture, due New York, Dec. 1, 1923. 1 at $500. No. 2620	480.00
4	Grand Rapids Gas Light Co., 5 per cent, first mortgage, gold, due New York, Aug. 1, 1939. 4 at $1,000. Nos. A522, A523, A595, A596	4,020.00
9	Milwaukee Railway & Electric Light Co., general and refunding mortgage gold, series A, 5 per cent, due New York Dec. 1, 1951. 9 at $1,000. Nos. 2088, 2772, 3839, 3840, 3930, 3931, 5222, 5223 5224	8,237.50
10	Minneapolis General Electric Co., 5 per cent, 30-year gold-mortgage, due New York, Dec. 1, 1934. 10 at $1,000. Nos. 1621, 1622, 1949, 2004, 2572, 2573, 2574, 2575, 7579, 7580	9,880.00
4	Niagara Falls Power Co., first mortgage, 5's, gold coupon, due Jan. 1, 1932. 4 at $1,000. Nos. 5246, 5247, 6583, 8358	4,100.00
18	Riggs Realty Co., 3/30-year coupon, first 5's, due Washington, D. C., Oct. 1, 1940. 18 at $1,000. Nos. 76, 80, 84, 88, 92, 96, 100, 104, 108, 112, 116, 120, 124, 128, 132, 136, 140, 144	18,572.50
1	Shawinigan Water & Power Co., 5's, due Jan. 1, 1934. 1 at $500. No. 5337	507.50
9	Southern Bell Telephone & Telegraph Co., 30-year, first mortgage, 5's, sinking fund, gold, due Jan. 1, 1941. 9 at $1,000. Nos. M9739, M11576, M11577, M11578, M11579, L13965, M15568, M15569, M15570	8,942.50
1	Union Electric Light & Power Co. of St. Louis, 5 per cent, first mortgage, 30-year, gold, due New York, Sept. 1, 1932. 1 at $1,000. No. 4169	1,010.00
5	Vicksburg, Shreveport & Pacific R. R. Co., prior lien mortgage, at 6 per cent, gold, renewed at 5 per cent, due Nov. 1, 1915; extended to Nov. 1, 1940. 5 at $1,000. Nos. 561, 661, 794, 982, 1323	5,050.00

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7 Virginian Ry. Co., first mortgage, 50-year gold, 5 per cent, due New York, Nov. 1, 1962. 7 at $1,000. Nos. M4290, M4291, M14151, M23824, M23823, M23822, M23821	$6,986.25	
		$162,873.50
3. Bank balance, Dec. 31, 1917[1]		16,865.30
		265,488.80

LIABILITIES.

	Income.	Capital.
General fund:		
Invested	$4,686.25	
Uninvested	602.99	
Agassiz fund:		
Invested		$50,000.00
Uninvested		
Bache fund:		
Invested	2,575.00	56,000.00
Uninvested	1,249.76	
Billings fund:		
Invested		2,500.00
Uninvested		
Building fund:		
Invested		9,000.00
Uninvested	399.29	
Comstock fund:		
Invested	677.50	12,318.75
Uninvested	854.25	87.27
Consolidated fund:		
Invested		
Uninvested	1,097.53	
Draper fund:		
Invested	1,952.50	10,000.00
Uninvested	594.89	
Elliot fund:		
Invested		8,000.00
Uninvested	517.22	
Gibbs fund:		
Invested		5,545.50
Uninvested	216.33	
Gould fund:		
Invested	4,067.50	19,942.50
Uninvested	1,642.67	57.50
Hale lectureship:		
Invested		
Uninvested	220.28	
Hartley fund:		
Invested		1,200.00
Uninvested	25.51	
Marsh fund:		
Invested		18,500.00
Uninvested	716.81	

[1] Outstanding checks, $901.86.

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	Income.	Capital.
Murray fund:		
Invested		$6,000.00
Uninvested	$569.61	
National Research Council:		
Invested		
Uninvested	2,389.35	
Proceedings:		
Invested		
Uninvested	1,922.27	
Smith fund:		
Invested	1,532.50	10,000.00
Uninvested	1,084.20	
Watson fund:		
Invested	1,003.75	24,796.25
Uninvested	799.32	203.75
	31,337.28	234,151.52
		31,337.28
		265,488.80
Consolidated investment fund:		
Invested		175,071.00
Uninvested	1,097.53	1,674.50

CONDENSED STATEMENT OF RECEIPTS AND EXPENDITURES, 1917.

RECEIPTS.

Balance, Jan. 1, 1917, as per last report		$29,551.64
Cash receipts:		
Total income from investments	[1] $11,711.87	
Mortgage notes paid	15,000.00	
Annual dues, 1916, 1917, 1918	795.00	
Interest on bank deposits	435.89	
William Ellery Hale lectureship	1,000.00	
Billings fund from Draper estate	2,500.00	
Contributions to Proceedings	2,480.00	
Subscriptions to Proceedings	1,105.57	
Reprints and separate numbers of Proceedings	939.29	
Cancellation of check for J. Voûte	200.50	
Return of grant to I. W. Bailey from Bache fund	300.80	
Return of grant to E. O. Hovey from Smith fund	525.00	
Receipts to credit National Research Council	6,487.20	
		43,481.12
Book transfers:		
Bond transfers	1,003.75	
Transfers on account of consolidated fund	10,275.82	
Transfers, income to capital	7,870.36	
Contribution from Hale lectureship to Proceedings	1,500.00	
Transfer from Billings fund income to Proceedings fund	87.55	
Distribution of income from consolidated fund	8,601.76	
		29,339.24
		102,372.00

[1] Interest to amount of $750 is due from an unsettled estate.

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EXPENDITURES.

Cash expenditures:		
Investment of capital	$33,615.00	
Investment of income	2,007.50	
Accrued interest on bonds purchased	260.34	
National Research Council	4,147.85	
		$40,030.69
Book transfers:		
Transfer of investments	1,003.75	
Distribution of income from consolidated fund	8,601.76	
Transfers from income to capital	7,870.36	
Transfers from various funds to consolidated fund	10,275.82	
Contribution Hale lectureship to Proceedings fund	1,500.00	
Transfer from Billings fund income to Proceedings fund	87.55	
		29,339.24
Payments from trust and other funds:		
Bache fund—		
H. W. Norris	100.00	
Irving W. Bailey	300.00	
J. P. Iddings	500.00	
F. A. Shull	500.00	
J. Voûte	216.40	
J. Voûte (canceled)	200.50	
F. A. Goodspeed	100.00	
T. H. Gronwall	100.00	
C. K. Drinker	350.00	
R. A. Daly	700.00	
Smith fund—		
G. P. Merrill	185.00	
C. C. Trowbridge	250.00	
S. A. Mitchell	400.00	
Draper fund—		
A. A. Michelson medal	213.12	
Marsh fund—		
J. M. Clarke	400.00	
Watson fund—		
J. A. Miller	250.00	
H. C. Wilson	325.00	
Gibbs fund—		
W. D. Haskins	200.00	
R. L. Datta	135.30	
Hartley fund—		
Medals	143.80	
Gould fund—		
Astronomical Journal	500.00	
General fund—		
Grant for tables of constants	200.00	
Hale lectureship fund—		
Honorarium	300.00	
		6,569.12

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Proceedings:		
Stationery	$37.09	
Salary, managing editor	750.00	
Printing and distributing	4,948.47	
Expenses, Boston office	412.50	
Rent of meeting room	3.00	
Expenses, Washington office	62.45	
		$6,213.51
General fund:		
Salary assistant secretary and treasurer	600.00	
Treasurer's office	190.00	
Home secretary's office	716.74	
Foreign secretary's office	59.33	
Memoirs, printing, etc	76.75	
Meetings—		
Annual	841.35	
Autumn	90.69	
Reception to French scientific mission	291.65	
Postage, telegrams	82.33	
Election of members	113.57	
Panama Canal slide report	291.73	
		3,354.14
		85,506.70
Balance, Dec. 31, 1917		16,865.30
		102,372.00

ACCOUNTS WITH INDIVIDUAL FUNDS JAN. 1 TO DEC. 31, 1917.

	General fund.		Agassiz fund.	
	Income.	Capital.	Income.	Capital.
Balance Jan. 1, 1917:				
Cash	$1,006.96			
Invested	4,686.25			$50,000.00
Receipts:				
Interest on deposits	435.89			
Interest on investments	2,714.28			
	8,843.38			50,000.00
Disbursements:				
General expenses	3,354.14			
Grants and medals	200.00			
Balance Dec. 31, 1917:				
Cash	602.99			
Invested	4,686.25			50,000.00
	8,843.38			50,000.00

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Accounts with individual funds Jan. 1 to Dec. 31, 1917—Continued.

	Bache fund.		Billings fund.	
	Income.	Capital.	Income.	Capital.
Balance Jan. 1, 1917:				
Cash	$899.35			
Invested	2,575.00	$56,000.00		$2,500.00
Receipts:				
Interest on investments	2,916.01		$87.55	
J. Voûte, canceled check	200.50			
Irving W. Bailey, return of grant	300.80			
	6,891.66	56,000.00	87.55	2,500.00
Disbursements:				
Grants and medals	2,850.00			
J. Voûte check canceled	200.50			
Expense cable to J. Voûte	16.40			
Transfer capital to consolidated				2,500.00
Transfer to Proceedings			87.55	
Balance Dec. 31, 1917:				
Cash	1,249.76			
Invested	2,575.00	56,000.00		
	6,891.66	56,000.00	87.55	2,500.00

	Building fund.		Comstock fund.	
	Income.	Capital.	Income.	Capital.
Balance Jan. 1, 1917:				
Cash			$1,297.32	$22.50
Invested		$8,954.03	677.50	11,315.00
Receipts:				
Interest on investments	$445.26		638.50	
Transfer income to capital				1,068.52
Transfer capital to consolidated		45.97		
	445.26	9,000.00	2,613.32	12,406.02
Disbursements:				
General expenses			13.05	
Transfer income to capital	45.97		64.77	
Transfer capital to consolidated			1,003.75	
Balance Dec. 31, 1917:				
Cash	399.29		854.25	87.27
Invested		9,000.00	677.50	12,318.75
	445.26	9,000.00	2,613.32	12,406.02

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Accounts with individual funds Jan. 1 to Dec. 31, 1917—Continued.

	Consolidated fund.		Draper fund.	
	Income.	Capital.	Income.	Capital.
Balance Jan. 1, 1917:				
Cash	$1,742.30	$8,161.18	$245.19	
Invested		151,666.00	1,952.50	$10,000.00
Receipts:				
Interest on investments	8,071.03		502.82	
Transfers from various funds		16,918.32		
	9,813.33	176,745.50	2,700.51	10,000.00
Disbursements:				
Grants and medals			213.12	
Distribution income consolidated	8,715.80			
Balance Dec. 31, 1917:				
Cash	1,097.53	1,674.50	534.89	
Invested		175,071.00	1,952.50	10,000.00
	9,813.33	176,745.50	2,700.51	10,000.00

	Elliot fund.		Gibbs fund.	
	Income.	Capital.	Income.	Capital.
Balance Jan. 1, 1917:				
Cash	$114.98		$272.25	
Invested		$8,000.00		$5,545.50
Receipts:				
Interest on investments	402.24		279.44	
	517.22	8,000.00	551.69	5,545.50
Disbursements:				
Grants and medals			319.00	
Expense cable to R. L. Datta			16.36	
Balance Dec. 31, 1917:				
Cash	517.22		216.33	
Invested		8,000.00		5,545.50
	517.22	8,000.00	551.69	5,545.50

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Accounts with individual funds Jan. 1, to Dec. 31, 1917—Continued.

	Gould fund.		Hale lectureship fund.	
	Income.	Capital.	Income.	Capital.
Balance Jan. 1, 1917:				
Cash	$929.06	$2,036.25	$1,000.00	.....
Invested	4,067.50	17,963.75	.....	.....
Receipts:				
Interest on investments	1,247.50	.....	33.33	.....
Transfer of investment	.....	.....	1,003.75	.....
Contribution to Hale lectureship	.....	.....	1,000.00	.....
	6,244.06	20,000.00	3,037.08	.....
Disbursements:				
General expenses	33.89	.....	13.05	.....
Grants and medals	500.00	.....	.....	.....
Transfer to Proceedings fund	.....	.....	1,500.00	.....
E. G. Conklin, Honorarium	.....	.....	300.00	.....
Investment of income	.....	.....	1,003.75	.....
Balance Dec. 31, 1917:				
Cash	1,642.67	57.50	220.28	.....
Invested	4,067.50	19,942.50	.....	.....
	6,244.06	20,000.00	3,037.08	.....

	M. Hartley fund.		Marsh fund.	
	Income.	Capital.	Income.	Capital.
Balance Jan. 1, 1917:				
Cash	$108.98	.....	$8,031.95	.....
Invested	.....	$1,200.00	677.50	$10,127.65
Receipts:				
Interest on investments	60.33	.....	779.71	.....
Capital from income	.....	.....	.....	8,372.35
	169.31	1,200.00	9,489.16	18,500.00
Disbursements:				
Grants and medals	143.80	.....	400.00	.....
Income from capital	.....	.....	8,372.35	.....
Balance Dec. 31, 1917:				
Cash	25.51	.....	716.81	.....
Invested	.....	1,200.00	.....	18,500.00
	169.31	1,200.00	9,489.16	18,500.00

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Accounts with individual funds Jan. 1, to Dec. 31, 1917—Continued.

	Murray fund.		National Research Council.	
	Income.	Capital.	Income.	Capital.
Balance Jan. 1, 1917:				
Cash	$274.97	$35.00	$50.00	
Invested		5,965.00		
Receipts:				
Interest on investments	294.64			
Contributions, National Research Council			6,487.20	
	569.61	6,000.00	6,537.20	
Disbursements			4,147.85	
Balance Dec. 31, 1917:				
Cash	569.61		2,389.35	
Invested		6,000.00		
	569.61	6,000.00	6,537.20	

	Proceedings fund.		Smith fund.	
	Income.	Capital.	Income.	Capital.
Balance Jan. 1, 1917:				
Cash	$1,228.37		$841.38	
Invested			1,532.50	$10,000.00
Receipts:				
Interest on investments			552.82	
E. O. Hovey, return of grant			525.00	
Billings fund income	87.55			
Hale lectureship to Proceedings fund	1,500.00			
Contributions to Proceedings	2,480.00			
Subscriptions to Proceedings	1,105.57			
Reprints and separate numbers	939.29			
Annual dues	795.00			
	8,136.78		3,451.70	10,000.00
Disbursements:				
General expenses	6,213.51			
Transfer income to capital			835.00	
Balance Dec. 31, 1917:				
Cash	1,922.27		1,084.20	
Invested			1,532.50	10,000.00
	8,135.78		3,451.70	10,000.00

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Accounts with individual funds Jan. 1, to Dec. 31, 1917—Continued.

	Watson fund.	
	Income.	Capital.
Balance Jan. 1, 1917:		
Cash	$1,176.15	$77.50
Invested		24,922.50
Receipts:		
Interest on investments	1,201.92	
	2,378.07	25,000.00
Disbursements:		
Transfer income to capital	575.00	
Balance Dec. 31, 1917:		
Cash	799.32	203.75
Invested	1,003.75	24,796.25
	2,378.07	25,000.00

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REPORT OF THE AUDITING COMMITTEE.

WASHINGTON, D. C., *January 14, 1918.*

We have employed the Capital Audit Co. to scrutinize and report on the treasurer's books. We accepted the certification, dated January 12, 1918, of the American Security & Trust Co. regarding notes on deposit owned by the academy, and we have examined the securities and papers contained in the box of the National Academy of Sciences at the vault of the American Security & Trust Co. We find them to correspond to the list checked by the auditing committee on January 17, 1917, except as modified by transactions of the year 1917 reported by the Capital Audit Co. We find that the coupons due in 1917 have been cut and are accounted for, and those due January 1, 1918, are detached and are accounted for by appropriate entries in the pass books. We find that interest on loans has been accounted for. Correspondence between vouchers, pass books, and accounts of the treasurer is certified by the Capital Audit Co. We find the balance reported by the treasurer as of December 31, 1917, to accord with the statement of the American Security & Trust Co. and with the check book.

C. G. ABBOT, *Chairman.*
W. F. DURAND,
ARTHUR L. DAY.

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APPENDIXES.

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APPENDIX A.

CONSTITUTION OF THE NATIONAL ACADEMY.

As amended and adopted April 17, 1872, and further amended April 20, 1875; April 21, 1881; April 19, 1882; April 18, 1883; April 19, 1888; April 18, 1895; April 20, 1899; April 17, 1902; April 18, 1906; November 20, 1906; April 17, 1907; November 20, 1907; April 20, 1911; April 16, 1912; April 21, 1915.

PREAMBLE.

Empowered by the act of incorporation enacted by Congress, and approved by the President of the United States on the 3d day of March, A. D. 1863, and in conformity with amendments to said act approved July 14, 1870, June 20, 1884, and May 27, 1914, the National Academy of Sciences adopts the following amended constitution and rules:

ARTICLE I.—OF MEMBERS.

SECTION 1. The academy shall consist of members, honorary members, and foreign associates. Members must be citizens of the United States.

SEC. 2. Members who, from age or inability to attend the meetings of the academy, wish to resign the duties of active membership, may, at their own request, be transferred to the roll of honorary members by a vote of the academy.

SEC. 3. The academy may elect 50 foreign associates.

SEC. 4. Honorary members and foreign associates shall have the privilege of attending the meetings and of reading and communicating papers to the academy, but shall take no part in its business, shall not be subject to its assessments, and shall be entitled to a copy of the publications of the academy.

ARTICLE II.—OF THE OFFICERS.

SECTION 1. The officers of the academy shall be a president, a vice president, a foreign secretary, a home secretary, and a treasurer, all of whom shall be elected for a term of six years, by a majority of votes present, at the first stated meeting after the expiration of the current terms, provided that existing officers retain their places until their successors are elected. In case of a vacancy, the election for six years shall be held in the same manner at the meeting when such

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vacancy occurs, or at the next stated meeting thereafter, as the academy may direct. A vacancy in the office of treasurer or home secretary may, however, be filled by appointment of the president of the academy until the next stated meeting of the academy.

SEC. 2. The officers of the academy, together with six members to be elected by the academy, shall constitute a council for the transaction of such business as may be assigned to them by the constitution or the academy.

SEC. 3. The president of the academy, or, in case of his absence or inability to act, the vice president, shall preside at the meetings of the academy and of the council; shall name all committees except such as are otherwise especially provided for; shall refer investigations required by the Government of the United States to members especially conversant with the subjects and report thereon to the academy at its meeting next ensuing; and, with the council, shall direct the general business of the academy.

It shall be competent for the president, in special cases, to call in the aid, upon committees, of experts or men of special attainments not members of the academy.

The president shall be, ex officio, a member of all committees empowered to consider questions referred to the academy by the Government of the United States.

SEC. 4. The foreign and home secretaries shall conduct the correspondence proper to their respective departments, advising with the president and council in cases of doubt, and reporting their action to the academy at one of the stated meetings in each year.

It shall be the duty of the home secretary to give notice to the members of the place and time of all meetings, of all nominations for membership, and of all proposed amendments to the constitution.

It shall be the duty of the home secretary to keep the minutes of each business and scientific session, and after approval to enter these upon the permanent records of the academy.

SEC. 5. The treasurer shall attend to all receipts and disbursements of the academy, giving such bond and furnishing such vouchers as the council may require. He shall collect all dues, assessments, and subscriptions, and keep a set of books showing a full account of receipts and disbursements and the condition of all funds of the academy. He shall be the custodian of the corporate seal of the academy.

ARTICLE III.—OF THE MEETINGS.

SECTION 1. That the academy shall hold one stated meeting, called the annual meeting, in April of each year in the city of Washington, and another stated meeting, called the autumn meeting, at a place to be determined by the council. The council shall also have power to fix the date of each meeting.

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Special business meetings of the academy may be called, by order of eight members of the council, at such place and time as may be designated in the call.

Special scientific meetings of the academy may be held at times and places to be designated by a majority of the council.

SEC. 2. The names of the members present at each session of a meeting shall be recorded in the minutes, and the members present at any session shall constitute a quorum for the transaction of business.

SEC. 3. Scientific sessions of the academy, unless otherwise ordered by a majority of the members present, shall be open to the public; sessions for the transaction of business shall be closed.

SEC. 4. Stated meetings of the council shall be held during the stated or special meetings of the academy and four members shall constitute a quorum for the transaction of business. Special meetings of the council may be convened at the call of the president and two members of the council, or of four members of the council.

SEC. 5. No member whose dues are in arrears shall vote at any business meeting of the academy.

ARTICLE IV.—OF ELECTIONS AND RESIGNATIONS.

SECTION 1. All elections of officers and members shall be by ballot, and each election shall be held separately.

SEC. 2. The time for holding an election of officers shall be fixed by the academy at least one day before the election is held.

SEC. 3. The election of the six members of the council shall be as follows:

At the annual meeting in April, 1907, six members of the council to be elected, of whom two shall serve for three years, two for two years, and two for one year, their respective terms to be determined by lot. Each year thereafter the terms of two members shall expire, and their successors, to serve for three years, shall be elected at the annual meeting in each year.

SEC. 4. The academy shall be divided by the council into sections representing the principal branches of scientific research. Each section shall elect its own chairman, who shall serve for three years. The chairman shall be responsible to the academy for the work of his section.

Nominations to membership in the academy shall be made in writing and approved by a majority of the members of the section on the branch of research in which the person nominated is eminent, or by a majority of the council in case there is no section on the subject. The nomination shall be sent to the home secretary by the chairman of the section before January 1 of the year in which the election is

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to be held, and each nomination shall be accompanied by a list of the principal contributions of the nominee to science. This list shall be printed by the home secretary for distribution among the members of the academy.

SEC. 5. Election of members shall be held at the annual meeting in Washington in the following manner: There shall be two ballots—a preference ballot, which may be prepared either before or at the annual meeting and must be transmitted to the home secretary, and a final ballot, to be taken at the meeting.

Preference ballot.—Each member may inscribe on a ballot not more than 15 names of nominees selected from the submitted list. A list of the nominees shall then be prepared, on which the names shall be entered in the order of the number of votes received by each. In case two or more nominees have the same number of votes on this preference list, the order in which they shall be placed on the list shall be determined by a majority vote of members present.

Final ballot.—A vote shall first be taken on the nominee who appears first on the preference list, and he shall be declared elected if he receive two-thirds of the votes cast and not less than 25 votes in all. A vote shall then be taken in similar manner on the nominee standing second on the preference list, and so on until all the nominees on the preference list shall have been acted on, or until 15 nominees shall have been elected or until the total membership of the academy shall have reached 250.

Not more than 15 members shall be elected at one annual meeting.

Before and during elections a discussion of the merits of nominees will be in order.

SEC. 6. Every member-elect shall accept his membership, personally or in writing, before the close of the next stated meeting after the date of his election. Otherwise, on proof that the secretary has formally notified him of his election, his name shall not be entered on the roll of members.

SEC. 7. Foreign associates may be nominated by the council and may be elected at the annual meeting by a two-thirds vote of the members present.

SEC. 8. A diploma, with the corporate seal of the academy and the signatures of the officers, shall be sent by the appropriate secretary to each member on his acceptance of membership, and to foreign associates on their election.

SEC. 9. Resignations shall be addressed to the president and acted on by the academy.

SEC. 10. Whenever a member has not paid his dues for four successive years, the treasurer shall report the fact to the council, which may report the case to the academy with the recommendation that the person thus in arrears be declared to have forfeited his membership.

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If this recommendation be approved by two-thirds of the members present, the said person shall no longer be a member of the academy and his name shall be dropped from the roll.

ARTICLE V.—SCIENTIFIC COMMUNICATIONS, PUBLICATIONS, AND REPORTS.

SECTION 1. Communications on scientific subjects shall be read at scientific sessions of the academy, and papers by any member may be read by the author or by any other member, notice of the same having been previously given to the secretary.

SEC. 2. Any member of the academy may read a paper from a person who is not a member, and shall not be considered responsible for the facts or opinions expressed by the author, but shall be held responsible for the propriety of the paper.

Persons who are not members may read papers on invitation of the council or of the committee of arrangements.

SEC. 3. The academy may provide for the publication, under the direction of the council, of proceedings, scientific memoirs, biographical memoirs, and reports.

The proceedings shall include the transactions of the academy, brief original announcements of the results of scientific investigations made by members of the academy or others, together with short original articles giving a comprehensive survey of the more important scientific researches currently made by American investigators, and other matters of general scientific interest.

The scientific memoirs shall provide opportunity for the publication of longer and more detailed scientific investigations.

The biographical memoirs shall contain an appropriate record of the life and work of deceased members of the academy.

An annual report shall be presented to Congress by the president and shall contain the annual reports of the treasurer and the auditing committee, a suitable summary of the reports of the committees in charge of trust funds, and a record of the activities of the academy for the calendar year immediately preceding, and other appropriate matter. This report shall be presented to Congress by the president after authorization by the council. It shall also be presented to the academy at the annual meeting next following.

The treasurer shall prepare a full report of the financial affairs of the academy at the end of the fiscal year. This report shall be submitted to the council for approval and afterwards presented to the academy at the annual meeting.

SEC. 4. Propositions for investigations or reports by the academy shall be submitted to the council for approval, except those requested by the Government of the United States, which shall be acted on by the president, who will in such cases report their results to the Gov-

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ernment as soon as obtained and to the academy at its next following stated meeting.

SEC. 5. The advice of the academy shall be at all times at the disposition of the Government upon any matter of science or art within its scope.

ARTICLE VI.—OF THE PROPERTY OF THE ACADEMY.

SECTION 1. All investments and reinvestments of either principal or accumulations of income of the trust and other funds of the academy shall be made by the treasurer, with the approval of the finance committee, in the corporate name of the academy, in the manner and in the securities designated or specified in the instruments creating the several funds, or, in the absence of such designation or specification, in bonds of the United States or of the several States, or in bonds or notes secured by first mortgages on real estate, in investments legal for savings banks under the laws of Massachusetts or New York, or in other bonds recommended to the treasurer by the fiscal advisers of the academy.

The treasurer may invest the capital of all trust funds of the academy which are not required by the instruments creating such funds to be kept separate and distinct, in a consolidated fund, and shall apportion the income received from such consolidated fund among the various funds composing the same in the proportion that each of said funds shall bear to the total amount of funds so invested; provided, however, that the treasurer shall at all times keep accurate accounts showing the amount of each trust fund, the proportion of the income from the consolidated fund to which it is entitled, and the expenses and disbursements properly chargeable to such fund.

SEC. 2. The council shall at its annual meeting in each year designate one bank or trust company in Washington, D. C., and one in New York City to act, when requested by the treasurer, as the fiscal advisers of the academy.

SEC. 3. The treasurer shall have authority, with the approval of the finance committee, to sell, transfer, convey, and deliver in the corporate name and for the benefit of the academy any stocks, bonds, or other securities standing in the corporate name.

SEC. 4. No contract shall be binding upon the academy which has not been first approved by the council.

SEC. 5. The assessments required for the support of the academy shall be fixed by the academy on the recommendation of the council and shall be payable within the calendar year for which they are assessed.

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ARTICLE VII.—OF TRUST FUNDS AND THEIR ADMINISTRATION.

SECTION 1. Devises, bequests, donations, or gifts having for their object the promotion of science or the welfare of the academy may be accepted by the council for the academy. Before the acceptance of any such trust the council shall consider the object of the trust and all conditions or specifications attaching thereto. The council shall make a report of its action to the academy.

SEC. 2. Medals and prizes may be established in accordance with the provisions of trusts or by action of the academy.

SEC. 3. Unless otherwise provided by the deed of gift, the income of each trust fund shall be applied to the objects of that trust by the action of the academy on the recommendation of a standing committee on that fund.

ARTICLE VIII.—OF ADDITIONS AND AMENDMENTS

Additions and amendments to the constitution shall be made only at a stated meeting of the academy. Notice of a proposition for such a change must be submitted to the council, which may amend the proposition, and shall report thereon to the academy. Its report shall be considered by the academy in committee of the whole for amendment.

The proposition as amended, if adopted in committee of the whole, shall be voted on at the next stated meeting, and if it receives two-thirds of the votes cast it shall be declared adopted.

Absent members may send their votes on pending changes in the constitution to the home secretary in writing, and such votes shall be counted as if the members were present.

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APPENDIX B.

RULES.

(In accordance with a resolution of the academy, taken at its meeting on April 21, 1915, the rules are arranged in groups and each group is numbered to correspond with the article of the constitution to which it relates.)

I.

1. The holders of the medal for emience in the application of science to the public welfare shall be notified, like members, of the meetings of the academy, and invited to participate in its scientific sessions.

II.

1. The proper secretary shall acknowledge all donations made to the academy, and shall at once report them to the council for its consideration.

2. The home secretary shall be the custodian of all books, apparatus, archives, and collections not explicitly assigned to other care.

3. The home secretary shall keep a record of all grants of money or awards of prizes or medals made from trust funds of the academy. The record for each grant of money shall include the following items:

1. Name of fund.
2. Date and number of the grant.
3. Name and address of recipient.
4. Amount of grant and date or dates of payment.
5. Purpose of grant.
6. Record or report of progress.
7. Resulting publications.

4. The treasurer shall keep the home secretary informed of all warrants received from directors of trust funds not controlled by the academy and of the date or dates of payment of all warrants.

5. The treasurer is authorized to defray, when approved by the president, all the proper expenses of committees appointed to make scientific investigations at the request of departments of the Government, and in each case to look to the department requesting the investigation for reimbursement to the academy.

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III.

1. The annual meeting of the academy shall begin on the fourth Monday of April. At the business sessions of the academy the order of procedure shall be as follows:

1. Chair taken by the president, or, in his absence, by the vice president.
2. Roll of members called by home secretary (first session of the meeting only).
3. Minutes of the preceding session read and approved.
4. Stated business.
5. Reports of president, secretaries, treasurer, and committees.
6. Business from council.
7. Other business.

2. The rules of order of the academy shall be those of the Senate of the United States, unless otherwise provided by the constitution or rules of the academy.

3. In the absence of any officer a member shall be chosen to perform his duties temporarily, by a plurality of *viva voce* votes, upon open nomination.

4. At each meeting the president shall announce the death of any members since the preceding meeting. As soon as practicable thereafter he shall designate a member to write—or to secure from some other source approved by the president—a biographical notice of each deceased member.

5. A standing committee of three members called the program committee, a local committee of five members appointed for each meeting, and the home secretary shall together constitute the committee of arrangements, of which the home secretary shall be chairman.

The term of service on the program committee shall be three years, one member retiring annually, the chairman to be designated by the president.

It shall be the duty of the program committee to prepare the scientific program for the annual meeting, and for this purpose it shall be empowered to solicit papers from members or others. It shall also be empowered to ascertain the length of time required for reading papers to be presented at the scientific sessions of the academy, and, when it appears advisable to limit the time to be occupied in their presentation or discussion.

The local committee shall meet not less than two months previous to each meeting. It shall prepare the detailed program of each day, and in general shall have charge of all business and scientific arrangements for the meeting for which it is appointed except those

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specifically assigned to the program committee in the case of the annual meeting.

IV.

1. The term of service of each chairman of a section shall be three years, to date from the closing session of the April meeting next following his election. Chairmen of sections shall be chosen by mail ballot, the member receiving the highest number of votes cast to be deemed elected. It shall be the duty of each retiring chairman to conduct the election of his successor and to report the result of the election to the home secretary before the April meeting at which his term of service expires. Should any section fail to elect a chairman before November 1, the president is empowered to appoint a temporary chairman to serve until the April meeting next following. No chairman shall be eligible for reelection for two consecutive terms.

2. The chairman of each section of the academy shall submit to the members of his section, not later than November 1 of each year, a ballot containing the names of all those persons who received lot less than two votes in the nominating ballot of the preceding year and of any other persons who were newly proposed for consideration at that time. Each member of the section shall be expected to return this ballot to the chairman within two weeks with his signature and with crosses placed against the names of those persons whom he is prepared to indorse for nomination. Each member may also write upon the ballot in a place provided for the purpose any new names which he desires to have included in the ballot to be submitted to the section in the following year. The vote resulting from this ballot shall be regarded as informal.

The chairman shall then submit to the members of his section a new ballot showing the results of the informal vote; and each member shall be expected to return this ballot to the chairman with his signature and with crosses placed against the names of those persons whom he will indorse for nomination. In order to secure an adequate number of nominations, the chairman, when necessary, shall obtain by personal solicitation a fuller vote of his section or shall submit to the section a supplementary formal ballot.

The chairman shall then certify to the home secretary, prior to January 1, the names of those persons who have been voted for on the formal ballots by a majority of the members of the section, and shall furnish him a list of the publications of these nominees, as required by the constitution.

3. Nominations for membership shall give the full name, residence, and the official positions successively held by the candidate, in addition to the list of his contributions to science required by the constitution.

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4. Preference ballots for election of members shall be sealed in a blank envelope, which shall be inclosed in another bearing the name of the sender, and which shall be addressed to the home secretary. Such envelopes shall be opened only by the tellers. If in any case the tellers are unable to determine who cast a ballot, or if the latter contains more names than are to be voted for, the ballot shall be rejected, but minor defects in a ballot shall be disregarded when the intent of the voter is obvious.

5. All discussions of the claims and qualifications of nominees at meetings of the academy shall be held strictly confidential, and remarks and criticisms then made may be communicated to no person who was not a member of the academy at the time of the discussion.

V.

1. The publication of the proceedings shall be under the general charge of the council, which shall have final jurisdiction upon all questions of policy relating thereto. The preparation of the proceedings for publication shall be intrusted to an editorial board. This board shall consist of a chairman and a managing editor, both of whom shall be appointed by the council for definite terms of service; of the home secretary and foreign secretary *ex officiis*, and of a body of associate editors representing the various branches of science which are to be included in the scope of the proceedings. The managing editor, who may be a nonmember of the academy, shall receive a salary, which shall be fixed by the council. It shall be the duty of the managing editor to prepare the proceedings in detail for publication; but the chairman of the editorial board shall decide, in consultation with the managing editor, in regard to the acceptance, rejection, or substantial modification of papers offered for publication. The associate editors shall be appointed by the council, upon recommendation of the chairman of the editorial board, for a period of three years, one-third of them retiring annually. The home secretary and the foreign secretary shall be responsible for the distribution of the proceedings in their respective fields.

2. Memoirs may be presented at any time to the home secretary, who shall report the date of their reception at the next session; but no memoir shall be published unless it has been read or presented by title before the academy.

Before publication all biographical and scientific memoirs must be referred to the committee on publication, who may, if they deem best, refer any memoir to a special committee appointed by the president to determine whether the same should be published by the academy.

3. Memoirs shall date, in the records of the academy, from the date of their presentation to the academy, and the order of their presenta-

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tion shall be so arranged by the secretary that, so far as may be convenient, those upon kindred topics shall follow one another.

4. The annual report of the treasurer shall contain:

1. A concise statement of the source, object, and amount of all trust funds of the academy.
2. A condensed statement of receipts and expenditures.
3. A statement of assets and liabilities.
4. Accounts with individual funds.
5. Such other matter as he considers appropriate.

5. The accounts of the treasurer shall, between January 1 and January 15 of each year, be audited by a committee of three members to be appointed by the president at the autumn meeting of the academy. It shall be the duty of the auditing committee to verify the record of receipts and disbursements maintained by the treasurer and the agreement of book and bank balances; to examine all securities in the custody of the treasurer and to compare the stated income of such securities with the receipts of record; to examine all vouchers covering disbursements for account of the academy and the authority therefor and to compare them with the treasurer's record of expenditures; to examine and verify the account of the academy with each trust fund. The auditing committee may employ an expert accountant to assist the committee in the examination of the books of the treasurer. The annual report of the treasurer shall be published with that of the president to Congress. The reports of the treasurer and auditing committee shall be presented to the academy at the annual meeting.

VI.

1. All apparatus and other materials of permanent value purchased with money from any grant from a trust fund shall be the property of the academy unless specific exception is made in the grant or by subsequent action of the council or the directors of the trust fund concerned. Receipts for all such property shall be signed by the grantee and shall be forwarded to the home secretary. All apparatus and unused material of value acquired in this way shall be delivered to the home secretary on completion of the investigation for which the grant was made, or at any time on demand of the council, and the home secretary shall give an appropriate release therefor.

2. The books, apparatus, archives, and other collections of the academy shall be deposited in some safe place in the city of Washington. A list of the articles so deposited shall be kept by the home secretary, who is authorized to employ a clerk to take charge of them.

3. A stamp corresponding to the corporate seal of the academy shall be kept by the secretaries, who shall be responsible for the due marking of all books and other objects to which it is applicable.

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Labels or other proper marks of similar device shall be placed upon objects not admitting of the stamp.

4. The fiscal year of the academy shall end on December 31 of each year.

5. The standing committee on finance shall consist of the treasurer ex officio as chairman and two members to be appointed annually by the president.

VII.

1. Standing committees of the academy on trust funds the income of which is applied to the promotion of research shall consist of three or five members. In order to secure rotation in office in such committees, when not in conflict with the provisions of the deeds of gift, the term of service on a committee of three members shall be three years; on a committee of five members the term shall be five years.

2. The annual reports of the committees on research funds shall, so far as the academy has authority to determine their form, give a current number to each award, stating the name, position, and address of the recipient; the subject of research for which the award is made, and the sum awarded; and in later annual reports the status of the work accomplished under each award previously made shall be announced, until the research is completed, when announcement of its completion and, if published, the title and place of publication shall be stated, and the record of the award shall be reported as closed.

VIII.

1. Any rule of the academy may be amended, suspended, or repealed on the written motion of any two members, signed by them, and presented at a stated meeting of the academy, provided the same shall be approved by a majority of the members present.

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APPENDIX C.

ORGANIZATION OF THE ACADEMY, 1917–18.

	Expiration of term.
WALCOTT, CHARLES D., *President*	April, 1923
MICHELSON, A. A., *Vice President*	April, 1923
HALE, GEORGE E., *Foreign Secretary*	April, 1922
DAY, ARTHUR L., *Home Secretary*	April, 1919
CROSS, WHITMAN, *Treasurer*	April, 1923

ADDITIONAL MEMBERS OF COUNCIL.

1915–1918.

COULTER, J. M. — HOWELL, W. H.

1916–1919.

CHITTENDEN, R. H. — PUPIN, M. I.

1917–1920.

CONKLIN, E. G. — NOYES, A. A.

SECTIONS.

1. MATHEMATICS.

BLISS, G. A.
BÔCHER, MAXIME
BOLZA, OSKAR
DICKSON, L. E.
KASNER, EDWARD
MOORE, E. H.
OSGOOD, W. F.
STORY, W. E.
VAN VLECK, E. B. (*Chairman, 1916–1919*)
WHITE, H. S.

2. ASTRONOMY.

ABBOT, C. G.
ADAMS, W. S.
BARNARD, E. E.
CAMPBELL, W. W. (*Chairman, 1917–1920*)
COMSTOCK, G. C.
ELKIN, W. L.
FROST, E. B.
HALE, G. E.
LEUSCHNER, A. O.
MOULTON, F. R.
PICKERING, E. C.
SCHLESINGER, FRANK

3. PHYSICS.

ABBOT, H. L.
AMES, J. S.
BARUS, CARL
BELL, A. G.
BUMSTEAD, H. A.
CARTY. J. J.
CREW, HENRY
DURAND, W. F.
HALL, E. H.
HASTINGS, C. S.
HAYFORD, J. F.
LYMAN, THEODORE
MENDENHALL, T. C.
MERRITT, ERNEST
MICHELSON, A. A.
MILLIKAN, R. A.
NICHOLS, E. F. (*Chairman, 1917–1920*)
NICHOLS, E. L.
PUPIN, M. I,
ROSA, E. B.
SABINE, W. C.
STRATTON, S. W.
THOMSON, ELIHU
TROWBRIDGE, JOHN
WEBSTER, A. G.
WOOD, R. W.
WOODWARD, R. S.

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4. CHEMISTRY.

BAXTER, G. P.
BOGERT, M. T.
BOLTWOOD, B. B.
CHANDLER, C. F.
CLARKE, F. W.
FRANKLIN, E. C.
GOMBERG, MOSES
GOOCH, F. A.
HILLEBRAND, W. F.
HOWE, H. M.
JACKSON, C. L.
LEWIS, G. N.
MICHAEL, ARTHUR
MORLEY, E. W.
MORSE, H. N.
NOYES, A. A.
NOYES, W. A.
OSBORNE, T. B.
REMSEN, IRA
RICHARDS, T. W.
(*Chairman, 1916–1919*)
SMITH, ALEXANDER
SMITH, EDGAR F.
STIEGLITZ, JULIUS
WELLS, H. L.
WHITNEY, W. R.

5. GEOLOGY AND PALEONTOLOGY.

BECKER, G. F.
BRANNER, J. C.
CHAMBERLIN, T. C.
CLARKE, J. M.
(*Chairman, 1918–1921*)
CROSS, WHITMAN
DALL, W. H.
DANA, E. S.
DAVIS, W. M.
DAY, A. L.
GILBERT, G. K.
IDDINGS, J. P.
KEMP, J. F.
LINDGREN, WALDEMAR
OSBORN, H. F.
PIRSSON, L. V.
PUMPELLY, RAPHAEL
RANSOME, F. L.
REID, H. F.
SCHUCHERT, CHARLES
SCOTT, W. B.
VAN HISE, C. R.
ULRICH, E. O.
WALCOTT, C. D.
WHITE, DAVID
WILLISTON, S. W.

6. BOTANY.

BAILEY, L. H.
BRITTON, N. L.
CAMPBELL, D. H.
COULTER, J. M.
FARLOW, W. G.
GOODALE, G. L.
HARPER, R. A.
SARGENT, C. S.
SMITH, ERWIN F.
(*Chairman, 1918–1921*)
THAXTER, ROLAND
TRELEASE, WILLIAM

7. ZOOLOGY AND ANIMAL MORPHOLOGY.

ALLEN, J. A.
CASTLE, W. E.
CONKLIN, E. G.
DAVENPORT, C. B.
DONALDSON, H. H.
HARRISON, R. G.
HOWARD, L. O.
JENNINGS, H. S.
LILLIE, F. R.
MARK, E. L.
MAYER, A. G.
MERRIAM, C. H.
MORGAN, T. H.
MORSE, E. S.
PARKER, G. H.
(*Chairman, 1916–1919*)
PEARL, RAYMOND
RIDGWAY, ROBERT
VERRILL, A. E.
WHEELER, W. M.
WILSON, EDMUND B.

8. PHYSIOLOGY AND PATHOLOGY.

ABEL, J. J.
BENEDICT, F. G.
CANNON, W. B.
CHITTENDEN, R. H.
COUNCILMAN, W. T.
CUSHING, HARVEY
FLEXNER, SIMON
FOLIN, OTTO
HALSTEAD, W. S.
HOWELL, W. H.
(*Chairman, 1916–1919*)
LEVENE, P. A. T.
LOEB, JACQUES
LUSK, GRAHAM
MELTZER, S. J.
MENDEL, L. B.
PRUDDEN, T. M.
SMITH, THEOBALD
VAUGHAN, V. C.
WELCH, W. H.
WOOD, H. C.

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9. ANTHROPOLOGY AND PSYCHOLOGY.

BOAS, FRANZ
CATTELL, J. McK.
DEWEY, JOHN
FEWKES, J. W. (*Acting Chairman*)
HALL, G. S.
HOLMES, W. H.
THORNDYKE, E. L.

STANDING COMMITTEES.

ON WEIGHTS, MEASURES, AND COINAGE.

MENDENHALL, T. C. (*Chairman*)
MICHELSON, A. A.
MORLEY, E. W.
WEBSTER, A. G.
WOODWARD, R. S.

ON SOLAR RESEARCH.

HALE, G. E. (*Chairman*)
CAMPBELL, W. W.
MICHELSON, A. A.
NICHOLS, E. L.
PICKERING, E. C.

ON PUBLICATION.

The PRESIDENT.
The HOME SECRETARY.
ROSA, E. B.

EDITORIAL BOARD OF THE PROCEEDINGS.

PEARL, RAYMOND (*Chairman*)
WILSON, EDWIN B. (*Managing Editor*)
DAY, A. L. (*Home Secretary*)
HALE, G. E. (*Foreign Secretary*)

ABEL, J. J., 1918.	IDDINGS, J. P., 1918.	MOORE, E. H., 1920.
CLARKE, J. M., 1918.	LOEB, JACQUES, 1920.	NOYES, A. A., 1919.
DONALDSON, H. H., 1919.	LUSK, GRAHAM, 1919.	SMITH, ALEXANDER, 1918.
FROST, E. B., 1920.	MAYER, A. G., 1919.	THORNDIKE, E. L., 1920.
HARPER, R. A., 1919.	MILLIKAN, R. A., 1918.	WHEELER, W. M., 1920.

ON COLLECTION OF HISTORICAL PORTRAITS, MANUSCRIPTS, INSTRUMENTS, ETC.

WALCOTT, C. D. (*Chairman*)
CLARKE, F. W.
HALE, G. E.
MELTZER, S. J.
PUPIN, M. I.

ON PROGRAM.

ABBOT, C. G. (*Chairman*), 1918.
THORNDYKE, E. L., 1929.
PEARL, RAYMOND, 1920.

FINANCE COMMITTEE.

CROSS, WHITMAN (*Chairman*)
HOWARD, L. O.
WALCOTT, C. D.

TRUST FUNDS.

THE BACHE FUND.

[$56,000.]

Researches in physical and natural science.

FROST, E. B. (*Chairman*)
HARRISON, R. G.
WEBSTER, A. G.

THE WATSON FUND.

[$25,000.]

Watson medal and the promotion of astronomical research.

LEUSCHNER, A. O. (*Chairman*)
COMSTOCK, G. C.
ELKIN, W. L.

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THE HENRY DRAPER FUND.

[$10,000.]

Draper medal and investigations in astronomical physics.

CAMPBELL, W. W. (*Chairman*), 1919. ABBOT, C. G. 1921. AMES, J. S., 1920.
HALE, G. E., 1918. MICHELSON, A. A., 1922.

THE J. LAWRENCE SMITH FUND.

[$10,000]

J. Lawrence Smith medal and investigations of meteoric bodies.

MORLEY, E. W. (*Chairman*), 1919. DANA, E. S., 1918. CROSS, WHITMAN, 1922.
PICKERING, E. C., 1920. WOOD, R. W., 1921.

THE BARNARD MEDAL.[1]

Meritorious service to science.

WOODWARD, R. S. (*Chairman*) CAMPBELL, W. W. NICHOLS, E. F.
NOYES, A. A. RICHARDS, T. W.

THE BENJAMIN APTHORP GOULD FUND.

[$20,000.]

Researches in astronomy.

MOULTON, F. R. (*Chairman*) BARNARD, E. E. WOODWARD, R. S.

THE WOLCOTT GIBBS FUND.

[$5.545.50.]

Chemical research.

JACKSON, C. L. (*Chairman*) RICHARDS, T. W. SMITH, EDGAR F.

THE COMSTOCK FUND.

[$12,406. 02.]

Researches in electricity, magnetism, and radiant energy.

NICHOLS, E. L. (*Chairman*), 1918. MILLIKAN, R. A., 1921. NOYES, A. A., 1919.
THOMPSON, ELIHU, 1920. WEBSTER, A. G., 1922.

THE MARSH FUND.

[$18,500.]

Original research in the natural sciences.

MOORE, E. H. (*Chairman*), 1919. DANA, E. S., 1920.
SCHUCHERT, CHARLES, 1918.

THE AGASSIZ FUND.

[$50,000.]

General uses of the academy.

THE MURRAY FUND.

[$6,000.]

Agassiz medal and contributions to oceanography.

DALL, W. H. (*Chairman*), 1918. DAVIS, W. M., 1919. PARKER, G. H., 1920.

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[1] Every five years the committee recommends the person whom they consider most deserving of the medal, and upon the approval of the Academy the name of the nominee is forwarded to the trustees of Columbia University, who administer the Barnard Medal Fund.

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THE MARCELLUS HARTLEY FUND.

[$1,200.]

Medal for eminence in the application of science to the public welfare.

BECKER, G. F. (*Chairman*), 1919. HILLEBRAND, W. F., 1919.
OSBORN, H. F., 1918. PUPIN, M. I., 1918. SMITH, THEOBALD, 1920.
WEBSTER, A. G., 1920.

THE JOSEPH HENRY FUND.

To assist meritorious investigators, especially in the direction of original research.

The sum of $40,000 was contributed by Fairman Rogers, Joseph Patterson, George W. Childs, and others, as an expression of their respect and esteem for Prof. Joseph Henry. This amount was deposited with the Pennsylvania Co. for the Insurance of Lives and Granting Annuities in Trust, with authorization to collect the income thereon and to pay over the same to Prof. Joseph Henry during his natural life, and after his death to his wife and daughters, and after the death of the last survivor to "deliver the said fund and the securities in which it shall then be invested to the National Academy of Sciences, to be thenceforward forever held in trust under the name and title of the 'Joseph Henry fund.'"

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MEMBERS OF THE NATIONAL ACADEMY OF SCIENCES.

DECEMBER 31, 1917.

		Date of election.
ABBOT, CHARLES GREELEY	*Smithsonian Institution, Washington, D. C.*	1915
ABBOT, HENRY L., U. S. A.	*23 Berkeley St., Cambridge, Mass.*	1872
ABEL, JOHN JACOB	*Johns Hopkins University, Baltimore, Md.*	1912
ADAMS, WALTER SYDNEY	*Solar Observatory Office, Pasadena, Cal.*	1917
ALLEN, J. ASAPH	*American Museum of Natural History, N. Y. City.*	1876
AMES, JOSEPH S.	*Johns Hopkins University, Baltimore, Md.*	1909
BAILEY, LIBERTY HYDE	*Ithaca, N. Y.*	1917
BARNARD, E. E.	*Yerkes Observatory, Williams Bay, Wis.*	1911
BARUS, CARL	*Brown University, Providence, R. I.*	1892
BAXTER, GREGORY PAUL	*T. J. Coolidge Jr. Mem. Lab., Cambridge, Mass.*	1916
BECKER, GEORGE F.	*U. S. Geological Survey, Washington, D. C.*	1901
BELL, A. GRAHAM	*1331 Connecticut Ave., Washington, D. C.*	1883
BENEDICT, FRANCIS GANO	*Nutrition Laboratory, Boston, Mass.*	1914
BLISS, GILBERT AMES	*University of Chicago, Chicago, Ill.*	1916
BOAS, FRANZ	*Columbia University, New York City.*	1900
BOGERT, MARSTON TAYLOR	*1023 16th Street, Washington, D. C.*	1916
BÔCHER, MAXIME	*Harvard University, Cambridge, Mass.*	1909
BOLTWOOD, B. B.	*Yale University, New Haven, Conn.*	1911
BOLZA, OSKAR	*Reichsgrafenstr. 10, Freiburg, Germany.*	1909
BRANNER, JOHN C.	*Stanford University, California.*	1905
BRITTON, NATHANIEL LORD	*New York Botanical Gardens, N. Y. City.*	1914
BUMSTEAD, HENRY ANDREWS	*Yale University, New Haven, Conn.*	1913
CAMPBELL, D. H.	*Stanford University, California.*	1910
CAMPBELL, WILLIAM W.	*Lick Observatory, Mount Hamilton, California.*	1902
CANNON, WALTER BRADFORD	*Harvard University, Cambridge, Mass.*	1914
CARTY, JOHN J.	*Am. Telegraph and Telephone Co., N. Y. City.*	1917
CASTLE, WILLIAM ERNEST	*186 Payson Road, Belmont, Mass.*	1915
CATTELL, JAMES MCK.	*Garrison, N. Y.*	1901
CHAMBERLAIN, THOMAS C.	*University of Chicago, Chicago, Ill.*	1903
CHANDLER, CHARLES F.	*Columbia University, New York, N. Y.*	1874
CHITTENDEN, RUSSELL H.	*Sheffield Scientific School, New Haven, Conn.*	1890
CLARKE, F. W.	*U. S. Geological Survey, Washington, D. C.*	1909
CLARKE, J. M.	*State Hall, Albany, N. Y.*	1909
COMSTOCK, GEORGE C.	*Washburn Observatory, Madison, Wis.*	1899
CONKLIN, E. G.	*Princton, N. J.*	1908
COULTER, J. M.	*University of Chicago, Chicago, Ill.*	1909
COUNCILMAN, WILLIAM T.	*Harvard Medical School, Boston, Mass.*	1904
CREW, HENRY	*Northwestern University, Evanston, Ill.*	1909
CROSS, WHITMAN	*2138 Bancroft Place, Washington, D. C.*	1908
CUSHING, HARVEY	*Harvard University, Cambridge, Mass.*	1917
DALL, WILLIAM H.	*Smithsonian Institution, Washington, D. C.*	1897
DANA, EDWARD S.	*Yale University, New Haven, Conn.*	1884

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		Date of election.
DAVENPORT, CHARLES B.	*Cold Spring Harbor, N. Y.*	1912
DAVIS, WILLIAM MORRIS	*31 Hawthorn St., Cambridge, Mass.*	1904
DAY, ARTHUR L.	*Geophysical Laboratory, Washington, D. C.*	1911
DEWEY, JOHN	*Columbia University, New York City.*	1910
DICKSON, LEONARD E.	*University of Chicago, Chicago, Ill.*	1913
DONALDSON, HENRY HERBERT	*Wistar Institute of Anatomy, Phila., Pa.*	1914
DURAND, WILLIAM FREDERICK	*Munsey Building, Washington, D. C.*	1917
ELKIN, WILLIAM L.	*Yale University Observatory, New Haven, Conn.*	1895
FARLOW, W. G.	*Harvard University, Cambridge, Mass.*	1879
FEWKES, JESSE WALTER	*Bureau of American Ethnology, Wash., D. C.*	1914
FLEXNER, SIMON	*Rockefeller Institute, New York City.*	1908
FOLIN, OTTO	*Harvard Medical School, Boston, Mass.*	1916
FRANKLIN, EDWARD CURTIS	*Stanford University, California.*	1914
FROST, EDWIN B.	*Yerkes Observatory, Williams Bay, Wis.*	1908
GILBERT, GROVE K.	*U. S. Geological Survey, Washington, D. C.*	1883
GOMBERG, MOSES	*University of Michigan, Ann Arbor, Mich.*	1914
GOOCH, FRANK A.	*Yale University, New Haven, Conn.*	1897
GOODALE, GEORGE L.	*Harvard University, Cambridge, Mass.*	1890
HALE, GEORGE E.	*Solar Observatory Office, Pasadena, Cal.*	1902
HALL, EDWIN H.	*Harvard University, Cambridge, Mass.*	1911
HALL, GRANVILLE STANLEY	*Clark University, Worcester, Mass.*	1915
HALSTED, WILLIAM STEWART	*Johns Hopkins Med. School, Baltimore, Md.*	1917
HARPER, R. A.	*Columbia University, New York City.*	1911
HARRISON, ROSS G.	*Yale University, New Haven, Conn.*	1913
HASTINGS, CHARLES S.	*Yale University, New Haven, Conn.*	1889
HAYFORD, JOHN F.	*Northwestern University, Evanston, Ill.*	1911
HILLEBRAND, WILLIAM F.	*Bureau of Standards, Washington, D. C.*	1908
HOLMES, WILLIAM H.	*U. S. National Museum, Washington, D. C.*	1905
HOWARD, LELAND OSSIAN	*U. S. Dept. of Agriculture, Washington, D. C.*	1916
HOWE, HENRY MARION	*Broad Brook Road, Bedford Hills, N. Y.*	1917
HOWELL, WILLIAM H.	*Johns Hopkins University, Baltimore, Md.*	1905
IDDINGS, JOSEPH P.	*U. S. Geological Survey, Washington, D. C.*	1907
JACKSON, CHARLES L.	*6 Boylston Hall, Cambridge, Mass.*	1883
JENNINGS, HERBERT SPENCER	*Johns Hopkins University, Baltimore, Md.*	1914
KASNER, EDWARD	*Columbia University, New York City.*	1917
KEMP, JAMES F.	*Columbia University, New York City.*	1911
LEUSCHNER, ARMIN O.	*University of California, Berkeley, Cal.*	1913
LEVENE, PHŒBUS AARON THEODOR	*Rockefeller Institute, New York City.*	1916
LEWIS, GILBERT N.	*University of California, Berkeley, Cal.*	1913
LILLIE, FRANK RATTRAY	*University of Chicago, Chicago, Ill.*	1915
LINDGREN, WALDEMAR	*Mass. Inst. of Technology, Cambridge, Mass.*	1909
LOEB, JACQUES	*Rockefeller Institute, New York City.*	1910
LUSK, GRAHAM	*Cornell University Medical College, New York City.*	1915
LYMAN, THEODORE	*Harvard University, Cambridge, Mass.*	1917
MARK, EDWARD L.	*109 Irving St., Cambridge, Mass.*	1903
MAYER, ALFRED GOLDSBOROUGH	*Carnegie Institution, Maplewood, N. J.*	1916
MELTZER, SAMUEL JAMES	*Rockefeller Institute, New York City.*	1912
MENDEL, LAFAYETTE B.	*18 Trumbull St., New Haven, Conn.*	1913
MENDENHALL, THOMAS C.	*329 North Chestnut St., Ravenna, Ohio.*	1887
MERRIAM, C. HART	*1919 16th St., Washington, D. C.*	1902
MERRITT, ERNEST	*Cornell University, Ithaca, N. Y.*	1914
MICHAEL, ARTHUR	*219 Parker St., Newton Center, Mass.*	1889

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		Date of election.
MICHELSON, ALBERT A.	*University of Chicago, Chicago, Ill.*	1888
MILLIKAN, ROBERT ANDREWS.	*University of Chicago, Chicago, Ill.*	1915
MOORE, ELIAKIM H.	*University of Chicago, Chicago, Ill.*	1901
MORGAN, T. H.	*Columbia University, New York City.*	1909
MORLEY, EDWARD W.	*West Hartford, Conn.*	1897
MORSE, EDWARD S.	*Salem, Mass.*	1876
MORSE, HARMON N.	*Johns Hopkins University, Baltimore, Md.*	1907
MOULTON, F. R.	*University of Chicago, Chicago, Ill.*	1910
NICHOLS, EDWARD L.	*Cornell University, Ithaca, N. Y.*	1901
NICHOLS, ERNEST F.	*Yale University, New Haven, Conn.*	1908
NOYES, ARTHUR A.	*Mass. Inst. of Technology, Cambridge, Mass.*	1905
NOYES, WILLIAM A.	*University of Illinois, Urbana, Ill.*	1910
OSBORN, H. F.	*American Museum of Natural History, New York City.*	1900
OSBORNE, T. B.	*Agricultural Experiment Station, New Haven, Conn.*	1910
OSGOOD, WILLIAM FOGG.	*Harvard University, Cambridge, Mass.*	1904
PARKER, GEORGE H.	*16 Berkeley St., Cambridge, Mass.*	1913
PEARL, RAYMOND.	*Maine Agricultural Experiment Station, Orono, Me.*	1916
PICKERING, EDWARD C.	*Harvard College Observatory, Cambridge, Mass.*	1873
PIERSON, LOUIS V.	*41 Trumbull St., New Haven, Conn.*	1913
PRUDDEN, T. MITCHELL.	*Columbia University, New York City.*	1901
PUMPELLY, RAPHAEL.	*Gibbs Avenue, Newport, R. I.*	1872
PUPIN, MICHAEL I.	*Columbia University, New York City.*	1905
RANSOME, FREDERICK LESLIE.	*U. S. Geological Survey, Washington, D. C.*	1914
REID, H. FIELDING.	*Johns Hopkins University, Baltimore, Md.*	1912
REMSEN, IRA.	*Johns Hopkins University, Baltimore, Md.*	1882
RICHARDS, THEODORE W.	*Wolcott Gibbs Mem. Lab., Cambridge, Mass.*	1899
RIDGWAY, ROBERT.	*U. S. National Museum, Washington, D. C.*	1917
ROSA, EDWARD B.	*Bureau of Standards, Washington, D. C.*	1913
SABINE, WALLACE C.	*Harvard University, Cambridge, Mass.*	1917
SARGENT, CHARLES S.	*Arnold Arboretum, Jamaica Plain, Mass.*	1895
SCHLESINGER, FRANK.	*Allegheny Observatory, Allegheny, Pa.*	1916
SCHUCHERT, CHARLES.	*Yale University, New Haven, Conn.*	1910
SCOTT, WILLIAM B.	*Princeton University, Princeton, N. J.*	1906
SMITH, ALEXANDER.	*Columbia University, New York City.*	1915
SMITH, EDGAR F.	*University of Pennsylvania, Philadelphia, Pa.*	1899
SMITH, ERWIN F.	*Bureau of Plant Industry, Washington, D. C.*	1913
SMITH, THEOBALD.	*Princeton, N. J.*	1908
STIEGLITZ, JULIUS.	*University of Chicago, Chicago, Ill.*	1911
STORY, WILLIAM E.	*Clark University, Worcester, Mass.*	1908
STRATTON, SAMUEL WESLEY.	*Bureau of Standards, Washington, D. C.*	1917
THAXTER, ROLAND.	*Harvard University, Cambridge, Mass.*	1912
THOMSON, ELIHU.	*Swampscott, Mass.*	1907
THORNDYKE, EDWARD LEE.	*Columbia University, New York City.*	1917
TRELEASE, WILLIAM.	*University of Illinois, Urbana, Ill.*	1902
TROWBRIDGE, JOHN.	*Harvard University, Cambridge, Mass.*	1878
ULRICH, EDWARD OSCAR.	*U. S. Geological Survey, Washington, D. C.*	1917
VAN HISE, C. R.	*University of Wisconsin, Madison, Wis.*	1902
VAN VLECK, E. B.	*University of Wisconsin, Madison, Wis.*	1911
VAUGHAN, VICTOR CLARENCE.	*University of Michigan, Ann Arbor, Mich.*	1915
VERRILL, A. E.	*47 Cedar Grove Avenue, New London, Conn.*	1872
WALCOTT, CHARLES D.	*Smithsonian Institution, Washington, D. C.*	1896
WEBSTER, ARTHUR G.	*Clark University, Worcester, Mass.*	1903

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		Date of election.
WELCH, WILLIAM H	*807 St. Paul St., Baltimore, Md.*	1895
WELLS, HORACE L	*Yale University, New Haven, Conn.*	1903
WHEELER, WILLIAM M	*Harvard University, Cambridge, Mass.*	1912
WHITE, DAVID	*U. S. Geological Survey, Washington, D. C.*	1912
WHITE, HENRY SEELY	*Vassar College, Poughkeepsie, N. Y.*	1915
WHITNEY, WILLIS RODNEY	*General Electric Co., Schenectady, N. Y.*	1917
WILLISTON, SAMUEL WENDELL	*University of Chicago, Chicago, Ill.*	1915
WILSON, EDMUND B	*Columbia University, New York City.*	1899
WOOD, HORATIO C	*4107 Chester Avenue, Philadelphia, Pa.*	1879
WOOD, ROBERT W	*Johns Hopkins University, Baltimore, Md.*	1912
WOODWARD, ROBERT S	*Carnegie Institution, Washington, D. C.*	1896

HONORARY MEMBER.

SMITH, SIDNEY I	*Yale University, New Haven, Conn.*	1884

FOREIGN ASSOCIATES.

ARRHENIUS, S. A	*Nobelinstitut, Stockholm.*	1908
BARROIS, CHARLES	*Université, Lille.*	1908
BRØGGER, W. C	*Universitet, Christiania.*	1903
CROOKES, SIR WILLIAM	*London.*	1913
DESLANDRES, HENRI	*Astrophysical Observatory, Meudon.*	1913
DEWAR, SIR JAMES	*University, Cambridge.*	1907
FISCHER, EMIL	*Chemisches Institut der Universität, Berlin.*	1904
FORSYTH, A. R	*Imperial College of Science and Technology, London.*	1907
GEIKIE, SIR ARCHIBALD	*Haslemere, Surrey.*	1901
GROTH, PAUL VON	*Universität, Munich.*	1905
HEIM, ALBERT	*Zürich.*	1913
HILBERT, DAVID	*Universität, Göttingen.*	1907
KAPTEYN, JOHN C	*Rijks Universiteit, Groningen.*	1907
KLEIN, FELIX	*Universität, Göttingen.*	1898
KÖSSEL, ALBRECHT	*Heidelberg.*	1913
KUSTNER, KARL FRIEDRICH	*Bonn.*	1913
LANKESTER, SIR E. RAY	*South Kensington, London.*	1903
LARMOR, SIR JOSEPH	*St. Johns College, Cambridge.*	1908
LORENTZ, HENDRIK ANTON	*Rijks Universiteit, Leiden.*	1906
OSTWALD, WILHELM	*Grossbothen, bei Leipzig.*	1906
PAVLOV, IVAN PETROVITCH	*Inst. for Experimental Medicine, Petrograd.*	1908
PENCK, ALBRECHT	*Universität, Berlin.*	1909
PFEFFER, WILHELM	*Botanische Institut der Universität, Leipzig.*	1903
PICARD, CHARLES ÉMILE	*Université, Paris.*	1903
RAYLEIGH, LORD	*University, Cambridge.*	1898
RETZIUS, GUSTAV	*Högskolan, Stockholm.*	1909
RUTHERFORD, SIR ERNEST	*University, Manchester.*	1911
SCHUSTER, ARTHUR	*Secretary of the Royal Society, London.*	1913
SEELIGER, HUGO RITTER VON	*Universität, Munich.*	1908
THOMSON, SIR JOSEPH	*University, Cambridge.*	1903
VOLTERRA, VITO	*Università, Rome.*	1911
VRIES, HUGO DE	*Universiteit, Amsterdam.*	1904
WAALS, JOHANNES D. VAN DER	*Amsterdam.*	1913
WALDEYER, WILHELM	*Universität, Berlin.*	1909
WOLF, MAX F. J. C	*Heidelberg.*	1913
WUNDT, WILHELM	*Universität, Leipzig.*	1909

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DECEASED MEMBERS.

	Date of election.	Date of death.
ABBE, CLEVELAND	1878 [1]	Oct. 28, 1916
AGASSIZ, ALEXANDER	1866	Mar. 27, 1910
AGASSIZ, LOUIS	(1)	Dec. 14, 1873
ALEXANDER, J. H.	(1)	Mar. 2, 1867
ALEXANDER, STEPHEN	(1)	June 25, 1883
BACHE, ALEXANDER DALLAS	(1)	Feb. 14, 1867
BAIRD, SPENCER F.	1864	Aug. 19, 1887
BARKER, GEORGE F.	1876 [2]	May 24, 1910
BARNARD, F. A. P.	(1) (2)	Apr. 27, 1889
BARNARD, J. G.	(1)	May 14, 1882
BARTLETT, W. H. C.	(1)	Feb. 11, 1893
BEECHER, CHARLES EMERSON	1899	Feb. 14, 1904
BILLINGS, JOHN S.	1883	Mar. 11, 1913
BOSS, LEWIS	1889 [2]	Oct. 5, 1912
BOWDITCH, HENRY P.	1887 [2]	Mar. 13, 1911
BREWER, WILLIAM H.	1880 [2]	Nov. 2, 1910
BROOKS, WILLIAM KEITH	1884	Nov. 12, 1908
BROWN SEQUARD, CHARLES E.	1868	Apr. 2, 1894
BRUSH, GEORGE JARVIS	1868 [2]	Feb. 6, 1912
CASEY, THOMAS L.	1890	Mar. 25, 1896
CASWELL, ALEXIS	(1)	Jan. 8, 1877
CHANDLER, SETH CARLO	1888 [2]	Dec. 31, 1913
CHAUVENET, WILLIAM	(1)	Dec. 13, 1870
CLARK, HENRY JAMES	1872	July 1, 1873
CLARK, WILLIAM B.	1908 [2]	July 27, 1917
COFFIN, JAMES H.	1869	Feb. 6, 1873
COFFIN, J. H. C.	(1)	Jan. 8, 1890
COMSTOCK, CYRUS B.	1884	May 29, 1910
COOK, GEORGE H.	1887	Sept. 22, 1889
COOKE, JOSIAH P.	1872	Sept. 3, 1894
COPE, EDWARD D.	1872 [2]	Apr. 12, 1897
COUES, ELLIOTT	1877	Dec. 25, 1899
CRAFTS, JAMES M.	1872 [2]	June 21, 1917
DALTON, J. C.	1864	Feb. 2, 1889
DANA, JAMES D.	(1) (2)	Apr. 14, 1895
DAVIDSON, GEORGE	1874 [2]	Dec. 2, 1911
DAVIS, CHARLES H.	(1)	Feb. 18, 1877
DRAPER, HENRY	1877	Nov. 20, 1882
DRAPER, JOHN W.	1877	Jan. 4, 1882
DUTTON, C. E.	1884 [2]	Jan. 4, 1912
EADS, JAMES B.	1872	Mar. 8, 1887
EMMONS, SAMUEL F.	1892	Mar. 28, 1911
ENGLEMANN, GEORGE	(1)	Feb. 4, 1884
FERREL, WILLIAM	1868	Sept. 18, 1891
FRASER, JOHN FRIES	(1)	Oct. 12, 1872
GABB, WILLIAM M.	1876	May 30, 1878
GENTH, F. A.	1872	Feb. 2, 1893
GIBBS, JOSIAH WILLARD	1879	Apr. 28, 1903
GIBBS, WOLCOTT	(1)	Dec. 9, 1908
GILL, THEODORE NICHOLAS	1873	Sept. 25, 1914
GILLISS, JAMES MELVILLE	(1)	Feb. 9, 1865
GOODE, G. BROWN	1888	Sept. 6, 1896
GOULD, AUGUSTUS A.	(1)	Sept. 15, 1866
GOULD, BENJAMIN A.	(1) (2)	Nov. 26, 1896

[1] Charter members, Mar. 3, 1863.

[2] Biographical notices have not been presented.

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Deceased members—Continued.

	Date of election.	Date of death.
GRAY, ASA	(1)	Jan. 30, 1888
GUYOT, ARNOLD	(1)	Feb. 8, 1884
HADLEY, JAMES	1872	Nov. 14, 1872
HAGUE, ARNOLD	1885 [2]	May 15, 1917
HALDEMAN, S. S	1876	Sept. 20, 1880
HALL, ASAPH	1875	Nov. 22, 1907
HALL, JAMES	(1) (3)	Aug. 7, 1898
HAYDEN, F. V	1873	Dec. 22, 1887
HENRY, JOSEPH	(1)	May 13, 1878
HILGARD, EUGENE W	1872 [2]	Jan. 8, 1916
HILGARD, JULIUS E	(1)	May 9, 1890
HILL, GEORGE WILLIAM	1874	Apr. 16, 1914
HILL, HENRY B	1883	Apr. 6, 1903
HITCHCOCK, EDWARD	(1)	Feb. 27, 1864
HOLBROOK, J. E	1868	Sept. 8, 1871
HOLDEN, EDWARD SINGLETON	1885	Mar. 16, 1914
HUBBARD, J. S	(1)	Aug. 16, 1883
HUMPHREYS, A. A	(1)	Dec. 27, 1883
HUNT T. STERY	1873 [2]	Feb. 12, 1892
HYATT, ALPHEUS	1875	Jan. 15, 1902
JAMES, WILLIAM [2]	1903	Aug. 26, 1910
JOHNSON, S. W	1866	July 21, 1909
KEELER, J. E	1900	Aug. 12, 1900
KING, CLARENCE	1876	Dec. 24, 1901
KIRTLAND, JARED P	1805	Dec. 10, 1877
LANE, J. HOMER	1872	May 3, 1890
LANGLEY, SAMUEL P	1876	Feb. 27, 1906
LEA, MATTHEW CAREY	1892	Mar. 15, 1897
LE CONTE, JOHN	1878	Apr. 29, 1891
LE CONTE, JOHN L	(1)	Nov. 15, 1883
LE CONTE, JOSEPH	1875	July 6, 1901
LEIDY, JOSEPH	(1)	Apr. 30, 1891
LESLEY, J. PETER	(1)	June 1, 1903
LESQUEREUX, LEO	1864	Oct. 20, 1889
LONGSTRETH, MIERS F	(1)	Dec. 27, 1891
LOOMIS, ELIAS	1873	Aug. 15, 1889
LOVERING, JOSEPH	1873	Jan. 18, 1892
LYMAN, THEODORE	1872	Sept. 9, 1897
MAHAN, D. H	(1)	Sept. 16, 1871
MALL, FRANKLIN P	1907 [2]	Nov. 17, 1917
MARSH, G. P	1866	July 23, 1882
MARSH, O. C	1874 [2]	Mar. 18, 1899
MAYER, ALFRED M	1872	July 13, 1897
MAYO-SMITH, RICHMOND	1890 [2]	Nov. 11, 1901
MEEK, F. B	1869	Dec. 21, 1876
MEIGS, M. C	1865	Jan. 2, 1892
MINOT, CHARLES SEDGWICK	1897 [2]	Nov. 19, 1914
MITCHELL, HENRY	1885 [2]	Dec. 1, 1902
MITCHELL, SILAS WEIR	1865 [2]	Jan. 4, 1914
MORGAN, LEWIS H	1875	Dec. 17, 1881
MORTON, HENRY	1874	May 9, 1902
NEF, JOHN ULRIC	1904 [2]	Aug. 13, 1915
NEWBERRY, J. S	(1)	Dec. 7, 1892
NEWCOMB, SIMON	1869 [2]	July 11, 1909

[1] Charter members, Mar. 3, 1863.

[2] Biographical notices have not been presented.

[3] Resigned in 1908 or 1909.

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Deceased members—Continued.

	Date of election.	Date of death.
NEWTON, H. A.	(1)	Aug. 12, 1896
NEWTON, JOHN	1876	May 1, 1895
NORTON, WILLIAM A	1873	Sept. 21, 1883
OLIVER, JAMES E	1872	Mar. 27, 1895
PACKARD, A. S	1872 [2]	Feb. 14, 1905
PENFIELD, SAMUEL L	1900	Aug. 13, 1906
PETERS, C. H. F	1876 [2]	July 18, 1890
PIERCE, BENJAMIN [3]	(1) (3)	Oct. 6, 1880
PIERCE, BENJAMIN OSGOOD	1906 [2]	Jan. 14, 1914
PIERCE, CHARLES SANTIAGO SANDERS	1876 [2]	Apr. 20, 1914
POURTALES, L. F	1873	July 19, 1880
POWELL, JOHN W	1880	Sept. 23, 1902
PUTNAM, FREDERICK W	1885 [2]	Aug. 18, 1915
RODGERS, JOHN	(1)	May 5, 1882
ROGERS, FAIRMAN	(1)	Aug. 22, 1900
ROGERS, ROBERT E [4]	(1)	Sept. 6, 1884
ROGERS, WILLIAM A	1885	Mar. 1, 1898
ROGERS, WILLIAM B [5]	(1)	May 30, 1882
ROOD, OGDEN N	1865	Nov. 12, 1902
ROWLAND, HENRY A	1881	Apr. 16, 1901
ROYCE, JOSIAH	1906 [2]	Sept. 14, 1916
RUTHERFURD, LEWIS M	(1)	May 30, 1892
SAXTON, JOSEPH	(1)	Oct. 26, 1873
SCHOTT, CHARLES A	1872	July 31, 1901
SCUDDER, SAMUEL H	1877 [2]	May 17, 1911
SELLERS, WILLIAM	1873 [2]	Jan. 24, 1905
SILLIMAN, BENJ., Sr	(1)	Nov. 24, 1864
SILLIMAN, BENJ., Jr	(1)	Jan. 14, 1885
SMITH, J. LAWRENCE	1872	Oct. 12, 1883
STIMPSON, WILLIAM	1868 [2]	May 26, 1872
STRONG, THEODORE	(1)	Feb. 1, 1879
SULLIVANT, W. S	1872	Apr. 30, 1873
TORREY, JOHN	(1)	Mar. 10, 1873
TOTTEN, J. G	(1)	Apr. 22, 1864
TROWBRIDGE, WILLIAM P	1872	Aug. 12, 1892
TRUMBULL, JAMES H	1872	Aug. 5, 1897
TUCKERMAN, EDWARD	1868	Mar. 15, 1886
WALKER, FRANCIS A	1878	Jan. 5, 1897
WARREN, G. K	1876	Aug. 8, 1882
WATSON, JAMES C	1868	Nov. 23, 1880
WATSON, SERENO	1889	Mar. 9, 1892
WHEELER, HENRY LORD	1909 [2]	Oct. 30, 1914
WHITE, CHARLES A	1889	June 29, 1910
WHITMAN, C. O	1895	Dec. 6, 1910
WHITNEY, JOSIAH D [6]	(1) (3)	Aug. 19, 1896
WHITNEY, WILLIAM D [6]	1865 [2]	June 29, 1894
WINLOCK, JOSEPH	(1)	June 11, 1875
WOODWARD, J. J	1873	Aug. 17, 1884
WORTHEN, A. H	1872	May 6, 1888
WRIGHT, ARTHUR WILLIAMS	1881 [2]	Dec. 19, 1915
WYMAN, JEFFRIES	(1)	Sept. 4, 1874
YOUNG, CHARLES A	1872	Jan. 3, 1908

[1] Charter members, Mar. 3, 1863.
[2] Biographical notices have not been presented.
[3] Resigned 1873.
[4] Dropped —, reelected 1875.
[5] Dropped —, reelected 1872.
[6] Resigned.

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DECEASED FOREIGN ASSOCIATES.

ADAMS, J. C.
AIRY, SIR GEORGE B.
ARGELANDER, F. W. A.
AUWERS, G. F. J. ARTHUR
BACKLUND, OSKAR
BAER, KARL ERNEST VON
BAEYER, ADOLF VON.
BARRANDE, JOACHIM
BEAUMONT, L. ÉLIE DE
BECQUEREL, HENRI
BERTHELOT, M. P. E.
BERTRAND, J. L. F.
BOLTZMANN, LUDWIG
BORNET, EDOUARD
BOUSSINGAULT, J. B. J. D.
BOVERI, THEODOR
BRAUN, ALEXANDER
BREWSTER, SIR DAVID
BUNSEN, ROBERT W.
BURMEISTER, C. H. C.
CANDOLLE, ALPHONSE DE
CAYLEY, ARTHUR
CHASLES, MICHEL
CHEVREUL, M. E.
CLAUSIUS, RUDOLPH
CORNU, ALFRED
DARBOUX, GASTON
DARWIN, SIR GEORGE HOWARD
DOVE, H. W.
DUMAS, J. B.
EHRLICH, PAUL
FARADAY, MICHAEL
GEGENBAUR, KARL
GLYDÉN, HUGO
GILL, SIR DAVID
HAMILTON, SIR WILLIAM ROWAN
HELMHOLTZ, BARON H. VON
HOFF, J. H. VAN'T
HOFMANN, A. W.
HOOKER, SIR JOSEPH D.
HUGGINS, SIR WILLIAM
HUXLEY, T. H.
IBAÑEZ, CARLOS
JANSSEN, J.
JOULE, JAMES P.
KEKULÉ, AUGUST
KELVIN, LORD
KIRCHOFF, G. R.
KOCH, ROBERT
KOHLRAUSCH, FRIEDRICH
KÖLLIKER, ALBERT VON
KRONECKER, HUGO
LACAZE-DUTHIERS, HENRI DE
LEUCKART, RUDOLPH
LIE, SOPHUS
LIEBIG, JUSTUS VON
LISTER, LORD
LOEWY, MAURICE
LUDWIG, K. F. W.
MAREY, E. J.
MENDELÉEFF, D. I.
MILNE-EDWARDS, HENRI
MOISSAN, HENRI
MURCHISON, SIR RODERICK I.
MURRAY, SIR JOHN
OPPOLZER, THEODORE VON
OWEN, SIR RICHARD
PASTEUR, LOUIS
PETERS, C. A. F.
PLANA, G. A. A.
POINCARÉ, JULES HENRI
RAMMELSBERG, C. F.
RAMSAY, SIR WILLIAM
REGNAULT, VICTOR
REYMOND, EMIL DU BOIS
RICHTHOFEN, F. VON
ROSENBUSCH, KARL HARRY FERDINAND
SACHS, JULIUS VON
SCHIAPARELLI, GIOVANNI
STAS, JEAN SERVAIS
STOKES, SIR GEORGE G.
STRASBURGER, EDOUARD
STRUVE, OTTO VON
SUESS, EDUARD
SYLVESTER, J. J.
TISSERAND, F. F.
VIRCHOW, RUDOLPH VON
VOGEL, H. C.
WEIERSTRASS, KARL
WEISMANN, AUGUST
WÖHLER, FRIEDRICH
WÜRTZ, ADOLPH
ZIRKEL, FERDINAND
ZITTELL, K. A R. VON

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REPORT

OF THE

NATIONAL ACADEMY OF SCIENCES

FOR THE YEAR

1918

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REPORT

OF THE

NATIONAL ACADEMY OF SCIENCES

FOR THE YEAR

1918

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1919

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CONTENTS.

	Page.
Letter of transmittal	5
Act of incorporation	6
Amendments	7
Meetings of the National Academy, 1918	9
Annual meeting	9
Members in attendance	9
Business sessions	9
Announcement by the President	9
Reports from officers of the academy	10
Report of the treasurer	11
Report of the home secretary	11
Report of the directors of the Bache fund	12
Report of the trustees of the Watson fund	13
Report of the committee on the Henry Draper fund	13
Report of the committee on the J. Lawrence Smith fund	15
Report of the directors of the Wolcott Gibbs fund	17
Report of the Comstock fund	18
Report of the committee on the Murray fund	19
Report of commission on the Marsh fund	19
Report of the editorial board of the proceedings	19
Report of the finance committee of proceedings	21
Award of medals	21
Election of officers and members	21
Scientific sessions	22
April 22	22
April 23	23
Autumn meeting	24
Members in attendance	24
Business sessions	24
Announcement of deaths	24
Biographical memoirs	24
Changes in editorial board of the proceedings	24
Resignation of home secretary	25
National Research Council, Executive order	25
National Research Council funds	26
London conference	26
Auditing committee	27
League of nations	27
Scientific sessions	27
November 18	27
November 19	28
Deceased members—	
Grove Karl Gilbert	28
Samuel Wendell Williston	34
Report of the National Research Council	39
The President's Executive order	39
Research information service	41
Organization of the International Research Council	50
Report of the patent committee	58
Promotion of industrial research	60
Financial support	61
Permanent organization	62
Reports of divisions	63
Division of general relations	63
Military division	68

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Report of the National Research Council—Continued.
Reports of divisions—Continued. Page.
Division of physical sciences 69
Engineering division 75
Section on metallurgy 75
Section on mechanical engineering 77
Section on electrical engineering 79
Section on prime movers 79
Division of chemistry and chemical technology 80
Activities of the committees of the division 81
Committee on explosives investigations 83
Committee on nitrate investigations 84
Division of geology and geography 86
General activities of the division 86
Cooperation with Government bureaus and other organizations ... 87
Division of medicine and related sciences 88
Division of biology 95
Publications 98
Acknowledgment 98
Report of the treasurer 98
War organization 101
Division of general relations 102
Military division 102
Research Information Service 103
Division of engineering 104
Division of physics, mathematics, astronomy, and geophysics 105
Division of chemistry and chemical technology 105
Division of geology and geography 107
Division of medicine and related sciences 107
Division of agriculture, botany, forestry, zoology, fisheries 108
Organization of the National Research Council 109
Annual report of the treasurer 113
General review of financial transactions 113
Trust funds of the academy 114
Statement of assets and liabilities 115
Condensed statement of receipts and expenditures 118
Accounts with individual funds 120
Report of auditing committee 126
Appendixes 128
Appendix A—Constitution of the National Academy 129
Appendix B—Rules 136
Appendix C—Organization of the academy, 1918-19 142
Sections 142
Standing committees 143
Trust funds 144
Members of the National Academy of Sciences, December 31, 1918 ... 146
Honorary member 149
Foreign associates 149
Deceased members 150
Deceased foreign associates 153

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LETTER OF TRANSMITTAL.

NATIONAL ACADEMY OF SCIENCES,
February 6, 1919.

The honorable THOMAS R. MARSHALL,
Vice President of the United States,
Washington, D. C.

SIR: I have the honor to transmit to you herewith the annual report of the president of the National Academy of Sciences for the year ending December 31, 1918.

Very respectfully,

CHARLES D. WALCOTT,
President.

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ACT OF INCORPORATION.

AN ACT To incorporate the National Academy of Sciences.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That Louis Agassiz, Massachusetts; J. H. Alexander, Maryland; S. Alexander, New Jersey; A. D. Bache, at large; F. B. Barnard,[1] at large; J. G. Barnard, United States Army, Massachusetts; W. H. C. Bartlett, United States Military Academy, Missouri; U. A. Boyden,[2] Massachusetts; Alexis Caswell, Rhode Island; William Chauvenet, Missouri; J. H. C. Coffin, United States Naval Academy, Maine; J. A. Dahlgren,[2] United States Navy, Pennsylvania; J. D. Dana, Connecticut; Charles H. Davis, United States Navy, Massachusetts; George Englemann, Saint Louis, Missouri; J. F. Frazer, Pennsylvania; Wolcott Gibbs, New York; J. M. Gilless,[3] United States Navy, District of Columbia; A. A. Gould, Massachusetts; B. A. Gould, Massachusetts; Asa Gray, Massachusetts; A. Guyot, New Jersey; James Hall, New York; Joseph Henry, at large; J. E. Hilgard, at large, Illinois; Edward Hitchcock, Massachusetts; J. S. Hubbard, United States Naval Observatory, Connecticut; A. A. Humphreys, United States Army, Pennsylvania; J. L. Le Conte, United States Army, Pennsylvania; J. Leidy, Pennsylvania; J. P. Lesley, Pennsylvania; M. F. Longstreth, Pennsylvania; D. H. Mahan, United States Military Academy, Virginia; J. S. Newberry, Ohio; H. A. Newton, Connecticut; Benjamin Peirce, Massachusetts; John Rodgers, United States Navy, Indiana; Fairman Rogers, Pennsylvania; R. E. Rogers, Pennsylvania; W. B. Rogers, Massachusetts; L. M. Rutherford, New York; Joseph Saxton, at large; Benjamin Silliman, Connecticut; Benjamin Silliman, junior, Connecticut; Theodore Strong, New Jersey; John Torrey, New York; J. G. Totten, United States Army, Connecticut; Joseph Winlock, United States Nautical Almanac, Kentucky; Jeffries Wyman, Massachusetts; J. D. Whitney, California; their associates and successors duly chosen, are hereby incorporated, constituted, and declared to be a body corporate, by the name of the National Academy of Sciences.

SEC. 2. *And be it further enacted*, That the National Academy of Sciences shall consist of not more than fifty ordinary members, and

[1] The official list of members gives the name of F. A. P. Barnard.
[2] Declined.
[3] The official list of members gives the name of J. M. Gillis.

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the said corporation hereby constituted shall have power to make its own organization, including its constitution, by-laws, and rules and regulations; to fill all vacancies created by death, resignation, or otherwise; to provide for the election of foreign and domestic members, the division into classes, and all other matters needful or usual in such institution, and to report the same to Congress.

SEC. 3. *And be it further enacted*, That the National Academy of Sciences shall hold an annual meeting at such place in the United States as may be designated, and the academy shall, whenever called upon by any department of the Government, investigate, examine, experiment, and report upon any subject of science or art, the actual expense of such investigations, examinations, experiments, and reports to be paid from appropriations which may be made for the purpose, but the academy shall receive no compensation whatever for any services to the Government of the United States.

SOLOMON FOOTE,
President of the Senate pro tempore.
GALUSHA A. GROW,
Speaker of the House of Representatives.

Approved, March 3, 1863.
ABRAHAM LINCOLN, *President.*

AMENDMENTS.

AN ACT To amend the act to incorporate the National Academy of Sciences.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the act to incorporate the National Academy of Sciences, approved March third, eighteen hundred and sixty-three, be, and the same is hereby, so amended as to remove the limitation of the number of ordinary members of said academy as provided in said act.

Approved, July 14, 1870.

AN ACT To authorize the National Academy of Sciences to receive and hold trust funds for the promotion of science, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the National Academy of Sciences, incorporated by the act of Congress, approved March third, eighteen hundred and sixty-three, and its several supplements, be, and the same is hereby, authorized and empowered to receive bequests and donations and hold the same in trust, to be applied by the said academy in aid of scientific investigations and according to the will of the donors.

Approved, June 20, 1884.

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AN ACT To amend the act authorizing the National Academy of Sciences to receive and hold trust funds for the promotion of science, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the act to authorize the National Academy of Sciences to receive and hold trust funds for the promotion of science, and for other purposes, approved June twentieth, eighteen hundred and eighty-four, be, and the same is hereby, amended to read as follows:

"That the National Academy of Sciences, incorporated by the act of Congress approved March third, eighteen hundred and sixty-three, be, and the same is hereby, authorized and empowered to receive, by devise, bequest, donation, or otherwise, either real or personal property, and to hold the same absolutely or in trust, and to invest, reinvest, and manage the same in accordance with the provisions of its constitution, and to apply said property and the income arising therefrom to the objects of its creation and according to the instructions of the donors: *Provided, however*, That the Congress may at any time limit the amount of real estate which may be acquired and the length of time the same may be held by said National Academy of Sciences."

SEC. 2. That the right to alter, amend, or repeal this act is hereby expressly reserved.

Approved, May 27, 1914.

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ANNUAL REPORT

OF THE

NATIONAL ACADEMY OF SCIENCES.

MEETINGS OF THE NATIONAL ACADEMY.

During the year 1918 the academy held two stated meetings, the annual meeting in April, at Washington, and the autumn meeting in November, at Baltimore, Md.

ANNUAL MEETING.

The annual meeting of the academy was held in the Smithsonian Institution in Washington, April 22, 23, and 24, 1918.

Fifty-eight members were present, as follows:

Abbot, C. G.
Ames, J. S.
Bailey, L. H.
Becker, G. F.
Benedict, F. G.
Campbell, W. W.
Carty, J. J.
Clarke, F. W.
Clarke, J. M.
Conklin, E. G.
Crew, Henry
Cross, Whitman
Dall, W. H.
Davenport, C. B.
Davis, W. M.
Donaldson, H. H.
Fewkes, J. W.
Flexner, Simon
Hale, G. E.
Halsted, W. S.
Hillebrand, W. F.
Howard, L. O.
Howell, W. H.
Iddings, J. P.
Kasner, Edward
Lillie, F. R.
Meltzer, S. J.
Mendel, L. B.
Mendenhall, T. C.
Merriam, C. H.
Michelson, A. A.
Millikan, R. A.
Morse, E. S.
Moulton, F. R.
Nichols, E. L.
Nichols, E. F.
Noyes, A. A.
Noyes, W. A.
Osborn, H. F.
Pearl, Raymond
Pupin, M. I.
Ransome, F. L.
Reid, H. F.
Rosa, E. B.
Schlesinger, Frank
Smith, Erwin F.
Stratton, S. W.
Thomson, Elihu
Ulrich, E. O.
Van Hise, C. R.
Van Vleck, E. B.
Walcott, C. D.
Webster, A. G.
Welch, W. H.
Wheeler, W. M.
White, David
Wilson, E. B.
Woodward, R. S.

BUSINESS SESSIONS.

ANNOUNCEMENT BY THE PRESIDENT.

The president announced that the home secretary, Mr. Arthur L. Day, would not be present, owing to absence from the city on matters relating to the war.

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REPORTS FROM OFFICERS OF THE ACADEMY.

The annual report of the president to Congress for 1917 was presented and distributed.

The president presented the following communication from Mr. R. S. Woodward, resigning the chairmanship of the committee on the Barnard medal:

WASHINGTON, D. C., *April 9, 1918.*

The HOME SECRETARY NATIONAL ACADEMY OF SCIENCES,
Smithsonian Institution, Washington, D. C.

DEAR SIR: Permit me to tender through your office to the council of the National Academy of Sciences my resignation as chairman of the committee on the Barnard medal. Like our late colleague, Prof. William James, I find that with advancing years it is desirable to relieve oneself of what he fittingly called "life's baggage." Having assisted at the birth of many of our American societies and served them in one way or another for many years, and having acted as the chairman of the committee on the Barnard medal for a decade, I am disposed to think it will be advantageous for me, for the academy, and for contemporary society to transfer the duties of the chairmanship of the committee in question to a younger man.

Faithfully, yours,

ROBERT S. WOODWARD.

The resignation of Mr. Robert S. Woodward as chairman of the committee on the Barnard medal was accepted with regret, Mr. T. H. Morgan was elected a member of the committee, and Mr. A. A. Noyes was elected chairman.

The president presented the following recommendations from the council:

That the Henry Draper medal be awarded to Walter Sidney Adams, Mount Wilson Observatory, for his investigations in astrophysics.

That the Daniel Giraud Elliot medal and honorarium be awarded to Dr. Frank M. Chapman, of the American Museum of Natural History, for having produced during the year 1917 his memoir, "The Distribution of Bird Life in Colombia, a Contribution to a Biological Survey of South America," Bulletin of the American Museum of Natural History, Volume XXXVI, pages vii–x, 1–729.

The award of the Henry Draper medal to Walter Sidney Adams and the Daniel Giraud Elliot medal and honorarium to Dr. Chapman were approved by the Academy.

The president announced the following changes in the personnel of the sections and committees:

Section of geology and paleontology.—J. M. Clarke, chairman.

Section of botany.—Erwin F. Smith, chairman.

Section of anthropology and psychology.—J. Walter Fewkes, acting chairman.

Local committee.—Whitman Cross (chairman), David White, Frederick L. Ransome, Raymond Pearl, Edward O. Ulrich.

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Committee on program.—E. L. Thorndike to serve unexpired term of J. McKeen Cattell, 1919.

Committee on the Henry Draper fund.—George E. Hale to succeed himself, term expiring 1923.

Committee on the J. Lawrence Smith fund.—E. S. Dana to succeed himself, term expiring 1923.

Committee on the Comstock fund.—E. L. Nichols to succeed himself as member and chairman, term expiring 1923.

Committee on the Marsh fund.—Charles Schuchert to succeed himself, term expiring 1921.

Committee on the Murray fund.—William H. Dall to succeed himself as member and chairman, term expiring 1921.

Committee on the Marcellus Hartley fund.—Henry F. Osborn and Michael I. Pupin to succeed themselves, terms expiring 1921.

REPORT OF THE TREASURER.

The report of the treasurer was presented in printed form and approved.

REPORT OF THE HOME SECRETARY.

APRIL 22, 1918.

The PRESIDENT OF THE NATIONAL ACADEMY OF SCIENCES,
Washington, D. C.

SIR: I have the honor to present the following report on the publications and membership of the National Academy of Sciences for the year ending April 24, 1918.

No scientific memoirs have been published during the year, but The Complete Classification of the Triad Systems in Fifteen Elements, by H. S. White, F. N. Cole, and Miss L. D. Cummins, recommended to be published as one of the memoirs of the National Academy of Sciences, was approved by the committee on publication and is now in the hands of the Public Printer. The actual publication may be delayed, owing to war conditions.

Of the biographical memoirs, that of John Shaw Billings, by S. Wier Mitchell, with the Scientific Work of John Shaw Billings, by Fielding H. Garrison, and of William Stimpson, by Alfred G. Mayer, have been published. The former has been distributed, while that of Stimpson has just come from the printer. The manuscript of the Biographical Memoir of James Dwight Dana, by L. V. Pirsson; Cleveland Abbe, by W. J. Humphreys; and William Bullock Clark, by John M. Clarke, are in the hands of the committee on printing; that of Benjamin O. Peirce, by Edwin H. Hall, is now in galley proof.

The Annual Report for 1917 has been published and is ready for distribution. The Proceedings of the Academy have been published regularly and have reached the third number of the fourth volume.

Four members have died since the last meeting. William Bullock Clark, elected in 1908, died July 27, 1917; James M. Crafts, elected in 1872, died June 21, 1917; Arnold Hague, elected in 1885, died May 15, 1917; Franklin Paine Mall, elected in 1907, died November 17, 1917, and one foreign associate. Adolf von Baeyer, died in August, 1917.

Fifteen new members were elected in April, 1917, making 157 active members on the present membership list, one honorary member, and 36 foreign associates.

ARTHUR L. DAY, *Home Secretary.*

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REPORT OF THE DIRECTORS OF THE BACHE FUND.

Since the annual meeting of the Academy in April, 1917, the following grants have been made:

No. 205, T. H. Goodspeed, University of California, $100. For studies of inheritance in Nicotiana hybrids.

No. 206. Reginald A. Daly. Harvard University, $700. For the completion of the deep-sea thermograph designed and partly constructed under grant No. 194. (In continuation of No. 194.)

No. 207, T. H. Gronwall, New York City, $300. To complete and extend mathematical researches on conformal representation.

No. 208, A. Franklin Shull, University of Michigan, $400. To investigate the cause of sex production and the life cycle of rotifers, together with artificial modification of life cycle; differential factors in fertilization of male-producing and female-producing rotifers; sex determination and the life cycle of the thrips; cause of sex production, wing production, and other cyclical phenomena in aphids.

No. 209. Cecil K. Drinker, Harvard Medical School, $350. For the closer study of the factors involved in extension of unchecked red cells and leucocytes in the dog.

No. 204. Irving W. Bailey, Bussey Institute. For field data for a study of environment upon the anatomical structure of angiosperms has been canceled and the money returned to the Treasurer because it was found impracticable for Prof. Bailey to go to Guatemala under present war conditions.

Reports of previous grants have been received as follows:

No. 193, C. A. Kofoid, University of California. For assistance in securing animals in the Indian jungle and in their preparation for study in research on the intestinal protozoa. Mr. Kofoid is serving as major in the Sanitary Corps and the work is being continued by research assistants on the material collected during Mr. Kofoid's travels.

No. 202, W. C. Allee, Lake Forest College, Ill. Research concluded on "The salt content of natural waters in relation to rhectaxis in Asellus," Biological Bulletin 32, 93–97. Preliminary results on first phase of investigation concerning a possible correlation between CO_2 production and phototaxis are completed and are in the hands of the editors of the Journal of Experimental Zoology. Research is in progress concerning the cause of formation of aggregations of may-fly nymphs and other reactions, and to CO_2 production. Also effect of molting on both above factors; also as to effect of the cyanides on respiration and reactions to various stimuli.

No. 203, J. P. Iddings, Brinklow, Md. The chemical analysis of igneous rocks collected in Asia and Australasia is completed and the results published in the Proceedings of this Academy. The work with the microscope and thin sections will continue for some years to come.

No. 205, T. H. Goodspeed, University of California. Between 20,000 and 25,000 measurements in the flower-size investigations on Nocotiana were made during the summer and fall of 1917. These experiments are to be concluded during the summer and results published thereafter.

No. 206, Reginald A. Daly, Harvard University. The deep-sea thermograph has been completed and a description has been published by its designer, Mr. Harry A. Clark, in the Bulletin of the Museum of Comparative Zoology at Harvard College, Volume LXI, No. 15.

No. 209. Cecil K. Drinker, Harvard Medical School. Research still in progress. A paper, entitled "The factors concerned in the appearance of nucleated red-blood corpuscles in the peripheral blood. II. Influence of procedures de-

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signed to increase the rate of blood flow through the blood-forming organs—hemorrhage and infusion," by Cecil K. Drinker, Katharine R. Drinker, and Henry A. Kreutzmann, was published in the Journal of Experimental Medicine, Volume XXVII, 383–397, 1918.

The directors have voted to transfer to capital account the sum of $2,575, which has been carried for a number of years as "invested income," together with $425 of current income, so that the principal of the fund now stands at $59,000.

An effort is being made to pay the American collaborators of the Nomenclator Animalium Generum et Subgenerum the amounts due them for their work. A grant of $1,000 was made in 1913 to Prof. F. E. Schulze, of Berlin, specifically for assistance by American men of science in this undertaking. It now seems probable that these men can soon receive their compensation. After providing for this liability of $1,000, the cash on hand available for grants on April 15, 1918, is $10.81.

E. B. FROST, *Chairman.*

REPORT OF THE TRUSTEES OF THE WATSON FUND.

At the annual meeting for 1917 a grant of $500 was voted to Prof. John A. Miller, director of the Sproul Observatory of Swarthmore College, Swarthmore, Pa., and a grant of $325 was voted to Prof. Herbert C. Wilson, of Carleton College, Northfield, Minn. The reports of the results achieved with the aid of these grants are essentially as follows:

Prof. Wilson is expending the appropriation for the services of an assistant in measuring and reducing photographic plates of asteroids for position and magnitude. The measurement and reduction of 97 plates has been completed. For 71, the results are published in Publications of Goodsell Observatory, No. 5. Of the 26 unpublished measures, 15 are of plates of seven Watson asteroids.

Mr. R. J. Wallace, director of the research laboratories of the Cramer Dry Plate Co., has made a color screen suitable for the 16-inch telescope, which has been highly satisfactory.

Prof. Miller is expending his appropriation for the services of an assistant in parallax determinations. A list of 50 parallaxes, together with a list of observations and reductions, has been published. A second list of 50 should be ready before the beginning of January, 1919.

The following vote is recommended:

Resolved, That $300 be appropriated for a continuance of the work conducted by Prof. Herbert C. Wilson, consisting of the determination of the position and brightness of asteroids (chiefly those discovered by Watson) by the photographic method, together with a study of the brightness of some variable stars.

Resolved, That the appropriation of $500 to Prof. John A. Miller be renewed for the year beginning July 1, 1918.

The available income of the Watson fund on April 1, 1918, was $1,590.57.

A. O. LEUSCHNER, *Chairman.*
W. L. ELKINS.
GEORGE C. COMSTOCK.

The report was adopted and appropriations authorized.

REPORT OF THE COMMITTEE ON THE HENRY DRAPER FUND.

No awards have been made in the past year; the reduced size of many observatory and laboratory staffs because of war activities has not permitted

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normal development of new methods in astrophysics, and there have been no urgent calls for special instruments.

A grant of $500 made to W. W. Campbell two years ago, to provide the mounting of an ultra-violet spectograph for use with the Crossley reflecting telescope, was expended, and the finished instrument was described in Lick Observatory Bulletin, No. 291, in May, 1917. This instrument has been used by Mr. Wright in photographing the spectra of all the brighter planetary nebulae in the northern two-thirds of the sky.

A grant of $300 made in April, 1917, to Prof. Joel Stebbins, of the University of Illinois, and a similar grant in like amount made earlier, are being applied, in accordance with agreement, in payment of part-time salary of an assistant to Dr. Stebbins in order to further the latter's development of the photo-electric cell photometer and the application to the study of variable stars. Quoting from Prof. Stebbins's report dated April, 1918:

"The photo-electric photometer has been improved until it is now from 10 to 20 times as sensitive as the selenium photometer. We can measure the brightness of stars three magnitudes fainter than those which it was possible to observe with the selenium instrument. About a dozen new bright variable stars have been discovered, of which eight have been announced at meetings of the American Astronomical Society. We are also carrying on studies of several known variables."

In further agreement with the terms of the grant, the University of Illinois has arranged to continue the assistant on full time in Prof. Stebbins's department after the close of the present academic year.

Respectfully submitted.

W. W. CAMPBELL, *Chairman.*

The report was accepted.

REASONS FOR THE AWARD OF THE HENRY DRAPER GOLD MEDAL OF THE NATIONAL ACADEMY OF SCIENCES TO DR. WALTER SIDNEY ADAMS.

Dr. Adams has discovered and developed a method of determining the distances of the stars, by means of the spectrograph, which the Henry Draper committee believes is one of the great advances in modern astronomy. Like most methods of high value, its fundamentals are exceedingly simple. The basic fact is that certain lines are enhanced in the spectra of stars of high absolute luminosity, and certain other lines are enhanced in the spectra of stars of low absolute luminosity; in other words, the intensities of certain lines increase continuously with increasing absolute luminosities, and the intensities of certain other lines increase continuously with decreasing absolute luminosities. The approximate distances of a few hundred of the nearer stars, measured by the older methods, are known. These distances enable us to compute the absolute magnitudes or luminosities of those stars. The correlation of these absolute magnitudes and the estimated relative intensities of the critical lines in their spectra have given Mr. Adams the power to determine the functional relations connecting these elements, and thus to determine the absolute magnitudes of stars not yet observed for distance. Knowing the magnitude of a star as observed from the earth and the absolute magnitude of the same star as determined by the spectrograph, the solution of a simple equation yields at once the value of the star's distance. Here is a powerful means of extending the list of stars whose distances are known, and the committee confidently expects that the method will be applied successfully to thousands of stars which are too distant for successful attack by the earlier methods. The

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method should in due time tell us much concerning the linear scale of the nearer parts of our stellar system. The secondary applications of the method to astronomical problems are likewise of great promise.

Mr. Adams has applied the spectrographic method to the determination of the distances of more than 500 stars, of the Harvard spectral classes, F to Mb, inclusive, and a comparison of his results with those obtained by the older methods as to rapidity and accuracy is a subject for congratulation.

The method has not yet been applied satisfactorily to stars of certain spectral classes, but it is hoped that the dependence of such spectra upon absolute luminosities or other elements may be found in the near future.

Dr. Adams's contributions to other lines of astronomical research have been many, extensive, and fruitful. We mention three:

The spectrographic determination of the sun's rotational speeds by comparing the motions of approach of the eastern limb and the motions of recession of the western limb with the apparent motions of approach or recession of points on the solar meridian passing through the earth. The results form a monumental contribution to the complicated and still unsolved problem of the solar rotation.

His long exposures on the spectra of the present-day faint remnants of new stars formerly brilliant have shown that these stars are now of the Wolf-Rayet type.

The more thorough application of high dispersion spectroscopy to the study of the sun's chromosphere. Prior to the establishment of the Mount Wilson Solar Observatory this was essentially a total solar eclipse problem. Stratification of the chromosphere has been studied by Adams without an eclipse at least as successfully as it had formerly been studied at times of total solar eclipse.

Respectfully submitted.

W. W. CAMPBELL,
Chairman Henry Draper Committee.

REPORT OF THE COMMITTEE ON THE J. LAWRENCE SMITH FUND.

The committee on the J. Lawrence Smith fund reports as follows:

No. 3. Edmund Otis Hovey, curator in the department of geology and invertebrate paleontology in the American Museum of Natural History, New York, received in 1909 a grant of $400 to aid in the study of certain meteorites. The pressure of administrative duties has been so severe that the investigation is suspended, at least for a time, and Dr. Hovey proposed to return the grant. The committee hesitated, but at last accepted the proposal, and the amount of the grant, together with interest, has been repaid to the treasurer of the academy.

No. 4. C. C. Trowbridge, professor of physics in Columbia University, New York, has received from 1909 to 1917, grants amounting to $1,400 to aid in the study of meteor trains. The work of the last year has consisted of the further collection of illustrations of meteor trains and the study of spectrum observations. No further grant is sought.

No. 6. S. A. Mitchell, professor of astronomy in the University of Virginia, University, Va., received in 1915 a grant of $500 to aid in securing observations of paths and radiants of meteors, and in computing orbits when the observations are sufficient; further grants of $300 were made in 1916 and 1917. The war lessened the number of observations secured during 1917, but this lessened number amounted to 4,231, making the whole number of observations about

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19,000. An abstract of results for 1917 has been published by Dr. Olivier in a recent number of Popular Astronomy.

The committee is unanimous in recommending a further grant of $300 in aid of this promising research.

Grant No. 7. Dr. George P. Merrill, of the United States National Museum, received last November a grant of $400 to aid in further study of certain elements in meteorites. Of this grant he has spent $185, and there remains to his credit $215.

The J. Lawrence Smith fund now has a cash balance of income of $1,188.85. There is also a balance of invested income amounting to $1,532.50.

For the committee,

EDWARD W. MORLEY, *Chairman.*

REPORT OF C. C. TROWBRIDGE FOR 1917 ON GRANT FROM THE J. LAWRENCE SMITH FUND.

APRIL 13, 1918.

Prof. EDWARD W. MORLEY, LL. D.,
Chairman of the Committee on the J. Lawrence Smith Fund,
National Academy of Sciences.

DEAR PROF. MORLEY: I beg to submit herewith a brief report relative to the grant made to me from the J. Lawrence Smith fund for aid in work on the atmosphere of the earth and to the trains of meteors.

The progress for the year 1917 has been as follows: Work has been continued on the collection of illustrations of meteor trains; on the study of meteor-train theories, and study of the spectrum observations.

It has been shown that there is good reason to believe that the spectra of trains observed indicate a gas phosphorescence similar to that of "active" nitrogen (nitrogen in the phosphorescent state) rather than the light from hot metals as believed by the various observers. Further observations of importance have been made on the auroral features of the meteor-train zone. This phase of the investigation is bound up with meteor-train study for the following reasons:

The meteor-train zone and the main aurora are the same; the potential gradient across this zone is probably the cause of the visual effects in both cases. The drift of the atmosphere as shown by drifting trains in the meteor-train zone unquestionably has an important bearing on the electric discharges which cause the auroral glow.

FINANCIAL STATEMENT.

Total funds received to Dec. 31, 1916	$1,153.50
Total expenditures to Dec. 31, 1916	1,020.67
Balance, Dec. 31, 1916	132.83
(As per financial statement submitted Mar. 26, 1917.)	
Received from treasurer, National Academy of Sciences, Mar. 22, 1917	250.00
Total	382.83

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EXPENDITURES IN 1917.

Jan. —, M. M. King, typewriting	$2.40
Feb. —, Science reprints	8.00
Mar. —, Exchange on Washington check	.10
Mar. 12, George Merritt, jr., assistant, 23 hours	13.80
Apr. 2, J. Boldtman, photographer	1.50
Apr. 2, Bureau of supplies, Columbia University	1.20
Apr. 30, J. Boldtman, photographer	3.40
May 1, George Merritt, jr., assistant	19.60
May 10, bureau of supplies, Columbia University	1.60
June 1, Amy E. Davis, assistant	36.00
June 15, Mabel Weil, assistant	62.70
June 18, Printing, New Era Printing Co	5.89
	156.19

CASH ON HAND, DECEMBER 31, 1917.

Balance in Corn Exchange Bank	149.90
Cash	1.45
Balance in Washington Savings Bank	75.29
	226.64

CONDENSED STATEMENT.

Total funds received		1,403.50
Total expenditures to Dec. 31, 1917	$1,176.86	
Balance	226.64	
		1,403.50

Respectfully, yours,

C. C. TROWBRIDGE.

REPORT OF THE DIRECTORS OF THE WOLCOTT GIBBS FUND.

The directors of the Wolcott Gibbs fund for chemical research respectfully present the following report to the National Academy of Sciences.

During the past year no application was received for a grant from the fund, and owing to the disorganization of chemical research by the war, it was not thought worth while to try to get applications.

Holders of grants at present have reported as follows:

Grants 2 and 5.—Prof. M. E. Holmes, of Connecticut College, finds that the exacting duties of her new position will prevent her from continuing her research, and has returned the unexpended balance of the two grants, amounting to $86.32.

Grant 6.—Prof. G. P. Baxter, of Harvard University, has spent $194.31 for material and apparatus since the last report. No platinum was bought, as the war had rendered it too expensive. The three researches described in the last report have been finished, and accounts of the results will be published soon. These were—

(*a*) Electrolytic deposition in a mercury cathode, and the atomic weight of cadmium, with C. H. Wilson. A slight loss was discovered and corrected experimentally, after which eight determinations gave the atomic weight of cadmium as 112.40.

(*b*) Impurities in silver and iodine, with L. W. Parsons. In 1 gram of the silver used for atomic weight determinations 0.004 mg. of gas were found; in

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the iodine, 0.002 mg. of gas. Most exacting spectroscopic tests showed no impurities in the silver. These results dispose of the criticisms of P. A. Garye on the Harvard atomic weight determinations.

(*c*) The ratio of arsenic trioxide to iodine, with L. A. Gontz. The atomic weight, 74.96, was found for arsenic.

In addition a fourth research has been started—

(*d*) The atomic weight of mercury, with Matsuenke Kobayashi. All these researches but the last have been stopped by the enlistment of the graduate students in war service.

Grants 4 and 7.—Prof W. D. Harkins, University of Chicago, has bought a vacuum pump for $55, and is about to buy a still more efficient one.

He has studied the "Secondary valence and Werner's coordination number from the standpoint of the amines of cobalt" with G. L. Clark.

The existence of the salt $CoCl_3.10NH_3$ has been established; and the phenomena observed in the formation of this compound have never been studied, and some of its physical constants. The work was broken off by the enlistment of Mr. Clark in the service of the Government before it could be brought to an end. It will be continued as soon as possible, as it promises to show either that Werner's constitution of the cobaltamines is incorrect or that his coordination number must be changed from 6 to 10. Other results of great interest are also indicated.

Grant 8.—Prof. R. L. Datta, Presidency College, Calcutta, has sent orders for organic chemicals amounting to £10, but has received none because of the war.

The treasurer reports that the unexpended income of the fund amounts to $360.87. This includes the sum of $86.32 refunded from grants 2 and 5.

CHARLES L. JACKSON, *Chairman.*

The report was accepted.

REPORT OF THE COMMITTEE ON THE COMSTOCK FUND.

CORNELL UNIVERSITY, ROCKEFELLER HALL,
Ithaca, N. Y., April 10, 1918.

To the PRESIDENT OF THE NATIONAL ACADEMY OF SCIENCES:

SIR: On behalf of the committee in charge of the Comstock fund, I beg to make the following report:

Five years having nearly elapsed since the first award of the Comstock prize to Prof. (now Lieut. Col.) R. A. Millikan, the committee met in Philadelphia at the time of the November (1917) sessions of the academy, four members being present. After careful consideration of various suggestions previously made in writing at the request of the chairman, the committee unanimously recommended that the second award of the Comstock prize be made by the academy to Samuel Jackson Barnett, professor of physics at Ohio State University, for his investigations on magnetization by rotation.

In this research the following fundamental and very important facts were established:

1. That there are within the iron currents of negative electricity in orbital revolution;

2. That these gyrostatic systems have inertia and are capable of definite orientation or arrangement by the rotation of the body without the action of any external magnetic field; and

3. That such orientation manifests itself as a magnetization of the body as a whole.

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The committee further recommended that as in the case of the first award, the value of the prize be $1,500.

Yours, very truly,

EDW. L. NICHOLS,
For the committee.

REPORT OF THE COMMITTEE ON THE MURRAY FUND.

On November 1 the sum to the credit of the Murray fund was $569.61. The treasurer suggested, and as chairman I approved of, the investment of the major part of this sum in Liberty bonds, which, should the council decide to offer the medal this year, could readily be turned into cash. * * *

Very respectfully,

WM. H. DALL,
Chairman, Committee on Murray Fund.

REPORT OF THE COMMITTEE ON THE MARSH FUND.

The committee on the Marsh fund report as follows:

Grant No. 1.—Dr. J. M. Clarke reports progress in the assembling of material for his study of mutualism symbiosis and dependent life among animals.

Grant No. 2.—The committee recommend the appropriation of $250 to M. Ferdinand Canu, of Versailles, France for investigation in cooperation with Dr. R. S. Bassler, of the United States National Museum, of the early Teritary bryozoa of North America.

ELIAKIM H. MOORE, *Chairman.*

Report accepted and appropriation approved.

AMENDMENT TO CONSTITUTION.

The following amendment to the constitution was presented from the Committee of the Whole and adopted:

That the constitution be amended by substituting in Article II, section 1, lines 3 and 6 (Report, 1916) the word "four" for the word "six," so that it will read: "For a term of four years * * *."

Article II, section 1, as amended, reads:

SECTION 1. The officers of the academy shall be a president, a vice president, a foreign secretary, a home secretary, and a treasurer, all of whom shall be elected for a term of four years by a majority of votes present at the first stated meeting after the expiration of the current terms: *Provided*, That existing officers retain their places until their successors are elected. In case of a vacancy, the election for four years shall be held in the same manner at the meeting when such vacancy occurs, or at the next stated meeting thereafter, as the academy may direct. A vacancy in the office of treasurer or home secretary may, however, be filled by appointment of the president of the academy until the next stated meeting of the academy.

REPORT OF THE EDITORIAL BOARD OF THE "PROCEEDINGS."

The following report from the editorial board of the Proceedings of the National Academy of Sciences was presented by the chairman:

The board submits to the academy the following report of its activities:

1. Three volumes of the Proceedings have been completed and four numbers of the fourth volume have been issued.

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The statistics as to the make-up of the third volume, both in respect of subject matter and of source of the contributions, have been printed in the Annual Report of the Academy for 1917, and need not now be repeated except so far as covers one point.

The statistics of articles by members of the academy as compared with articles by nonmembers are interesting mainly in showing a progressive diminution in the percentage of articles by members, despite the increase in membership of the academy. If there are obstacles which can be removed and which hinder members of the academy from printing in the Proceedings, would it not be well to make efforts to remove them? The academy represents the highest point in American research, and if the Proceedings should actually contain articles representing the totality of the investigations of members of the academy, it would become thereby largely representative of all American research and of very high grade; and, furthermore, it would be more truly the proceedings of the academy in the sense that corresponding publications of foreign academies are representative of their research.

2. At the autumn meeting the terms of office of five members of the editorial board expired, and new appointments were made by the council as follows: Jacques Loeb, W. M. Wheeler, E. B. Frost, E. L. Thorndike, and E. H. Moore.

3. At the autumn meeting the board decided to put into operation certain changes in the typographical make-up of the Proceedings in the interest of economy. These changes have been made with satisfactory results.

4. The editorial board is of the opinion that in view of the now established and recognized position of the Proceedings as a medium of scientific publication, the members of the academy might well contribute more of their own papers to its pages than they now do, both from the standpoint of self-interest as well as from a sense of duty to the academy and what it stands for. In this connection the board would recommend that the academy adopt as a general principle the policy of requiring each recipient of a grant for research from any of its special funds to publish some account of the results of the researches under the grant in the Proceedings.

5. If the above recommendation is adopted, the board would further recommend that the academy suggest to the several committees having in charge trust funds from which grants are made that whenever accounts of researches under grants are published in the Proceedings there shall be paid over from the trust funds out of which the grants are made to the Proceedings account, if such action be permissible under the terms of the bequest, a sum of money to cover the expense of the publication at a rate of $6 per printed page.

Respectfully submitted.

RAYMOND PEARL, *Chairman.*

RECOMMENDATIONS FROM THE COUNCIL.

The following recommendations from the editorial board of the Proceedings through the Council were approved by the academy and the home secretary was instructed to bring these recommendations to the attention of the members of the academy and the chairmen of the trust funds:

That members of the academy be requested to contribute their own papers to the Proceedings.

That the policy of requiring each recipient of a grant for any research from any of the special funds to publish an account of the results of the researches under the grant in the Proceedings be approved.

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That the academy request the committees and trustees of the several trust funds of the academy from which grants are made that whenever accounts of researches under grants are published in the Proceedings there shall be paid over, from the trust fund out of which the grants are made, to the Proceedings account, if such action is permissible under the terms of the bequest, a sum of money to cover the expense of the publication.

REPORT OF FINANCE COMMITTEE OF THE "PROCEEDINGS."

The estimated net cost of the Proceedings for 1918 is $5,600.

The estimated income is as follows:

From subscriptions (provided each member of the academy becomes responsible for one subscription)	$1,800
One-third guaranty fund of $2,500 is	833
Estimated income of Billings fund	187
Sundry other income (members' dues, $850; N. R. C., $400; Dr. Walcott, special, $100)	1,350
Total estimated income	4,170
Total estimated deficit	1,430

If recommendation of the editorial board that space for reports of special grants in Proceedings be specially paid for be adopted, this deficit will be reduced to $1,200.

The committee plans to raise funds to meet this deficit.

C. B. DAVENPORT, *Chairman.*
FRANK R. LILLIE.
RAYMOND PEARL.

AWARD OF MEDALS.

At the annual dinner held Tuesday evening at the Cosmos Club the following medals and awards were presented:

The Comstock prize of $1,500 for discoveries in magnetism and electricity was awarded to Samuel Jackson Barnett, Ohio State University, Columbus, Ohio.

The Draper medal for discoveries in astronomical physics to Walter Sydney Adams, Mount Wilson Solar Observatory, Pasadena, Cal.

The Daniel Giraud Elliot medal and honorarium for work in zoology to Frank M. Chapman, American Museum, New York.

ELECTIONS.

MEMBERS OF THE COUNCIL.

W. H. Howell, to succeed himself, term expiring in 1921.

C. G. Abbot, to succeed John M. Coulter, term expiring in 1921.

NEW MEMBERS.

Robert Grant Aitken, astronomer, Lick Observatory, California.

George Francis Atkinson, botanist, Cornell University, Ithaca, N. Y.

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George David Birkhoff, mathematician, Harvard University, Cambridge, Mass.

Percy Williams Bridgman, physicist, Harvard University, Cambridge, Mass.

Stephen Alfred Forbes, zoologist, Urbana, Ill.

John Ripley Freeman, engineer, Providence, R. I.

Charles Judson Herrick, neurologist, University of Chicago, Chicago, Ill.

Ludvig Hektoen, pathologist, University of Chicago, Chicago, Ill.

Frank Baldwin Jewett, engineer, Western Electric Co., New York, N. Y.

Walter Jones, physiologist, Johns Hopkins University, Baltimore, Md.

Irving Langmuir, chemist, General Electric Co., Schenectady, N. Y.

Charles Elwood Mendenhall, physicist, University of Wisconsin, Madison, Wis.

John Campbell Merriam, paleontologist, University of California, Berkeley, Cal.

Henry Norris Russell, astronomer, Princeton University, Princeton, N. J.

David Watson Taylor, engineer, rear admiral and Chief of the Bureau of Construction and Repair, United States Navy.

ADJOURNMENT.

The president, in closing, stated the present condition of the aircraft work of the Government.

The home secretary was requested to transmit the thanks of the academy to the Secretary of the Smithsonian and the officers of the United States National Museum and to the Cosmos Club for the courtesies extended to the members of the academy during the annual meeting.

PROGRAM OF SCIENTIFIC SESSIONS.

MEETING OF APRIL 22–24, 1918.

MONDAY, APRIL 22.

MORNING SESSION.

The effects of a prolonged reduced diet on 25 college men.—Francis G. Benedict: I. On basal metabolism and nitrogen excretion. Walter R. Miles (introduced by F. G. Benedict): II. On neuromuscular processes and mental condition (illustrated). H. Monmouth Smith (introduced by F. G. Benedict): III. On efficiency during muscular work and general muscular condition (motion pictures).

W. S. Halsted: The partial occlusion of great arteries in man and animals (illustrated).

S. J. Meltzer: Three papers (illustrated).—(*a*) The favorable effect of subcutaneous injection of magnesium sulphate in tetanus. (*b*) The possible danger

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of intravenous injection of magnesium sulphate. (c) The antagonistic and curative action of calcium salts in these cases.

Henry Fairfield Osborn: The Liberty field hospital ward. Designed on the unit-construction plan. Portable. Adapted to American overseas summer and winter service (motion pictures).

Simon Flexner: The war and medical research (illustrated).

AFTERNOON SESSION.

Edward Kasner: Conformal geometry.

S. J. Barnett (by invitation. Comstock prize recipient): Magnetism by rotation (illustrated).

A. A. Michelson: On the correction of optical surfaces.

W. W. Campbell: Some recent observations of the brighter nebulæ (illustrated).

R. A. Millikan: Physical researches for the war.

First William Ellery Hale lecture, by John C. Merriam, professor of paleontology, University of California. Subject: "The beginnings of human history from the geologic record."

TUESDAY, APRIL 23.

MORNING SESSION.

F. W. Clarke: Notes on isotopic lead.

Lawrence J. Henderson (introduced by Raymond Pearl): The physico-chemical properties of gluten.

Thomas Wayland Vaughan (introduced by David White): Correlation of the Tertiary formations of the southeastern United States, Central America, and the West Indies.

W. M. Davis: Coast survey charts and fringing reefs of the Philippine Islands (illustrated).

Henry Fairfield Osborn and William K. Gregory: Recent researches on the skeletal adaptations and modes of locomotion of the sauropod dinosaurs (illustrated).

Charles D. Walcott: Some additional data on the Cambrian Trilobites (illustrated).

C. R. Van Hise: The development of governmental regulations during the world war.

AFTERNOON SESSION.

C. Hart Merriam: The big bears of North America.

G. H. Parker: The growth of the Pribilof fur-seal herd between 1912 and 1917 (illustrated).

Henry H. Donaldson: A comparison of the growth changes in the nervous system of the rat with the corresponding changes in man (illustrated).

Robert M. Yerkes (by invitation): Measuring the mental strength of an army (illustrated).

Second William Ellery Hale lecture, by John C. Merriam, professor of paleontology, University of California. Subject: "The beginnings of human history from the geologic record."

Arthur Gordon Webster: Some considerations on the exterior ballistics of a gun of 75 miles range.

J. P. Iddings (read): Biographical memoir of the late Arnold Hague.

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C. G. Abbot (read): Periodicity in the variation of the sun.

John M. Clarke (read by title): Biographical memoir of the late William Bullock Clark.

Edwin H. Hall (read by title): Ionization in solid metals.

E. L. Nichols and H. L. Howes: On the types of decay of phosphorescence.

AUTUMN MEETING.

The autumn meeting of the academy was held in the Johns Hopkins club room, Johns Hopkins University, Baltimore, Md., November 18 and 19, 1918.

The following members were present:

Abbot, C. G.	Gomberg, Moses	Merriam, J. C.
Abel, J. J.	Halsted, W. S.	Michelson, A. A.
Ames, J. S.	Harrison, R. G.	Moulton, F. R.
Bliss, G. A.	Holmes, W. H.	Nichols, E. F.
Campbell, D. H.	Howard, L. O.	Pupin, M. I.
Castle, W. E.	Howe, H. M.	Ransome, F. L.
Clarke, F. W.	Howell, W. H.	Russell, H. N.
Clarke, J. M.	Iddings, J. P.	Smith, E. F.
Conklin, E. G.	Jennings, H. S.	Thorndike, E. L.
Cross, Whitman	Jones, Walter	Vaughan, V. C.
Davenport, C. B.	Leuschner, A. O.	Walcott, C. D.
Davis, W. M.	Lewis, G. N.	Webster, A. G.
Franklin, E. C.	Lindgren, Waldemar	Welch, W. H.
Freeman, J. R.	Mendenhall, C. E.	Wood, R. W.

BUSINESS SESSIONS.

ANNOUNCEMENT OF DEATHS.

The president announced the following deaths: S. W. Williston and G. K. Gilbert.

ASSIGNMENT OF BIOGRAPHICAL MEMOIRS.

Memoir of Richmond Mayo Smith assigned to Edwin R. A. Seligman, Samuel W. Williston to Richard S. Lull, G. K. Gilbert to William M. Davis.

PROCEEDINGS.

The president announced the following changes in the board of editors:

Retiring in 1918: J. J. Abel, J. M. Clarke, J. P. Iddings, R. A. Millikan, and Alexander Smith.

New members, retiring in 1921: J. M. Clarke, Ludvig Hektoen, H. S. Jennings, R. A. Millikan, and W. A. Noyes.

The managing editor of the Proceedings, Mr. E. B. Wilson, was reelected for the year ending November 30, 1919.

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RESIGNATION OF THE HOME SECRETARY.

The resignation of the home secretary, Mr. Arthur L. Day, was presented with the statement that the pressure of duties in connection with war activities would keep him away from Washington, and that he was severing his connection with the Geophysical Laboratory in order to undertake a greater war responsibility in connection with the Corning Glass Works, at Corning, N. Y. The academy approved the recommendation of the council that the resignation of Mr. Arthur L. Day as home secretary be accepted with an expression of regret that he feels compelled to give up the home secretaryship, and of appreciation for his valuable services in that office. The election of a home secretary was left for consideration at the next stated meeting of the academy, as provided for in the constitution.

NATIONAL RESEARCH COUNCIL.

The president presented the following communication from the President of the United States:

NATIONAL RESEARCH COUNCIL.

EXECUTIVE ORDER ISSUED BY THE PRESIDENT OF THE UNITED STATES MAY 11, 1918.

The National Research Council was organized in 1916 at the request of the President by the National Academy of Sciences, under its congressional charter, as a measure of national preparedness. The work accomplished by the council in organizing research and in securing cooperation of military and civilian agencies in the solution of military problems demonstrates its capacity for larger service. The National Academy of Sciences is, therefore, requested to perpetuate the National Research Council, the duties of which shall be as follows:

1. In general, to stimulate research in the mathematical, physical, and biological sciences, and in the application of these sciences to engineering, agriculture, medicine, and other useful arts, with the object of increasing knowledge, of strengthening the national defense, and of contributing in other ways to the public welfare.

2. To survey the larger possibilities of science, to formulate comprehensive projects of research, and to develop effective means of utilizing the scientific and technical resources of the country for dealing with these objects.

3. To promote cooperation in research, at home and abroad, in order to secure concentration of efforts, minimize duplication, and stimulate progress; but in all cooperative undertakings to give encouragement to individual initiative, as fundamentally important to the advancement of science.

4. To serve as a means of bringing American and foreign investigators into active cooperation with the scientific and technical services of the War and Navy Departments and with those of the civil branches of the Government.

5. To direct the attention of scientific and technical investigators to the present importance of military and industrial problems in connection with the war and to aid in the solution of these problems by organizing specific researches.

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6. To gather and collate scientific and technical information at home and abroad, in cooperation with governmental and other agencies, and to render such information available to duly accredited persons.

Effective prosecution of the council's work requires the cordial collaboration of the scientific and technical branches of the Government, both military and civil. To this end representatives of the Government, upon the nomination of the president of the National Academy of Sciences, will be designated by the President as members of the council, as heretofore, and the heads of the departments immediately concerned will continue to cooperate in every way that may be required.

WOODROW WILSON.

THE WHITE HOUSE, *May 11, 1918.*

FUNDS AVAILABLE FOR THE NATIONAL RESEARCH COUNCIL

Carnegie Institution	$100,000.00
W. W. Keen	483.57
Rockefeller Foundation	50,000.00
President's fund	120,000.00
Total available for fiscal year 1919	270,483.57

LONDON CONFERENCE.

The President read the following resolutions adopted at a conference of delegates from the national academies of countries at war with the central powers held at London October 9, 1918, received from the foreign secretary, Mr. Hale, who was chairman of the delegation from the National Academy of Sciences, the other members being Messrs. A. A. Noyes, W. F. Durand, S. Flexner, H. A. Bumstead, and J. J. Carty:

(1) That a committee of inquiry be constituted by the conference, the academies of the countries at war with the central powers having power to add further members. This committee shall prepare a general scheme of international organizations to meet the requirements of the various branches of scientific and industrial research, including those relating to national defense. (The committee will meet in Paris during the second fortnight in November.)

(2) Each of the academies represented at the conference shall be invited to initiate the formation of a national council for the promotion of the researches specified in resolution (1).

(3) An international council, having as nucleus the committee specified in resolution (1), shall be formed by the federation of national councils.

(4) The conference being of the opinion that all industrial, agricultural, and medical progress depend on pure science, draws the attention of the various Governments to the importance of theoretical and disinterested researches, which after the restoration of peace should be supported by large endowments. The conference urges similarly the creation of large laboratories for experimental science, both private and national.

Moved: That the action of the academy delegates favoring the above resolutions adopted by the interallied conference in London be entered in the minutes and approved by the academy.

Adopted.

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LIBRARY.

The following recommendation from the council was considered:

Moved: That the council recommend that the academy go on record as favoring the donation of publications of a scientific and technical character for its library.

Adopted.

AUDITING COMMITTEE.

The president announced the appointment of Mr. C. G. Abbot, Mr. L. O. Howard, and Mr. David White to audit the accounts of the treasurer.

PETITION TO CONGRESS.

Mr. Davis presented for the consideration of individual members of the academy the following petition for transmission to Congress and moved its adoption:

The undersigned members of the National Academy of Sciences, meeting in Baltimore, November 18, 1918, petition the Congress of the United States to take action, in consultation with the Governments of many other countries, toward the formation at as early a date as possible of a league of nations for the maintenance of peace.

This was signed by many members and transmitted to Congress.

The home secretary was requested to transmit the thanks of the academy to the president and trustees of Johns Hopkins University, the members of the Johns Hopkins Club, and the members of the academy resident in Baltimore serving as the local committee for the courtesies extended to the members of the National Academy of Sciences at the autumn meeting, 1918.

SCIENTIFIC SESSIONS.

NOVEMBER 18 AND 19, 1918.

Cloud reflection and the albedo of the earth and Venus.—C. G. Abbot.

Colorimetry of white surfaces.—A. H. Pfund, introduced by J. S. Ames.

The inorganic constituents of lobster shells.—F. W. Clarke and G. Steiger.

Quantitative relations between chromatin and cytoplasm in the genus Arcella, with their relations to external characters.—R. W. Hegner, introduced by H. S. Jennings.

The physiological effects of air concussion.—D. R. Hooker, introduced by W. H. Howell.

Two new factors in blood coagulation.—W. H. Howell.

Comparative morbidity of white and colored troops.—C. B. Davenport and Albert G. Love.

Theory of wind instruments.—A. G. Webster.

On the ballistic resistance function.—A. G. Webster.

On the dynamics of the rifle fired from the shoulder.—A. G. Webster.

Second report on the researches on the chemical and mineralogical composition of meteorites.—G. P. Merrill.

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Hydrocephalus: Experimental and clinical study (illustrated).—W. E. Dandy.

Clinical and experimental observations in cases of arterio-venous and lymphatico-venous fistulae (illustrated).—W. S. Halsted.

Is the arrangement of the genes in the chromosome linear? (illustrated)—W. E. Castle.

Cause of Phyllomania in Begonia (illustrated).—E. F. Smith.

Recent epidemics of pneumonia in army camps (illustrated).—W. G. MacCallum, introduced by H. S. Jennings.

Differential corrections of ballistics.—G. A. Bliss.

Some results of studies of influenza at an army camp.—Dr. Wolbach.

Communicable diseases in an army camp.—V. C. Vaughan.

Physiological effects of light of short wave length.—R. W. Wood.

The following read by title:

Kinetics and thermodynamics.—G. N. Lewis.

Perturbations and tables of the minor planets discovered by James C. Watson, Part II.—A. O. Leuschner.

Mathematical tables.—C. E. Van Orstrand.

Biography of George Davidson.—W. W. Campbell.

Biography of James Mason Crafts.—C. R. Cross.

Biography of Alpheus Spring Packard.—T. D. A. Cockerell.

Biography of Eugene Waldemar Hilgard.—F. Slate, jr.

DECEASED MEMBERS.

GROVE KARL GILBERT.[1]

By Herman Leroy Fairchild.

Grove Karl Gilbert was one of the most eminent geologists of the world. As he was a native of Rochester and an honorary member of this society,[2] the Academy of Sciences has special pride in his life and work.

Dr. Gilbert was born in Rochester, May 6, 1843. His father was the well-known portrait painter, Grove Sheldon Gilbert. For many years the family lived in the little house at the intersection of Culver Road and Merchants Road, but Karl was not born there. He had six brothers and sisters. The usual want of thrift and acquisitiveness in men of the artistic temperament held in the case of the father, and it appears that the family was poor and that Karl had to obtain some help for his course in college. He graduated as bachelor of arts at the university in 1862.

Following his graduation he taught for one year as principal of the schools in Jackson, Mich. He then returned to Rochester and until 1868 was assistant to Henry A. Ward. This work on the geologic and zoologic material of Ward's establishment probably determined his future scientific career. Many thousands of the labels

[1] Memoir presented to the Rochester Academy of Sciences.
[2] Rochester Academy of Sciences.

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in the University Geological Museum, which was the famous Ward collection, carry the pen work of young Gilbert.

In 1869 he began, on the Ohio Geological Survey, under Prof. J. S. Newberry, his geologic work. That this work was deliberate choice appears from the "Historical sketch" by Newberry, in the report for 1869 (p. 9), where we read:

> Of the other members of the corps, Messrs. Gilbert and Sherwood were geologists who had devoted much time to practical geology in New York and Pennsylvania, and who, for the purpose of adding to their experience, volunteered their services for no other compensation than their traveling expenses.

In the report for 1870 Dr. Newberry writes:

> The fossil fishes and fossil plants found in the State have been described by myself. They have been drawn by Mr. T. Y. Gardner and Mr. G. K. Gilbert in a style that has not been surpassed in this country, and some of their work is equal to any of a similar character done by the best European draftsman (p. 8).

This volume contains a short report by Gilbert on three counties in the northwestern part of the State.[1] A fuller report on the same district is attached to a report on the surface geology of the Maumee Valley, found in volume 1, of the final reports of the Newberry survey. This writing, published in 1873, contains six maps, evidently all his own work. The first two maps show the beaches of the ancient glacial waters in the Maumee Valley, and the correlation of the highest shore with the pass at Fort Wayne.

These fine maps are the first ever made in delineation of ancient lake beaches and correlation with the controlling outlet. The field work for this report was done in 1869 and 1870, when he was only 27 years of age. At this time Gilbert did not recognize the receding ice sheet as the dam that held up the ancient waters, but he did clearly postulate deformation of the earth's surface as one cause of the variation of levels. He says (p. 551):

> The more general conclusion that the system of raised beaches signify a succession of flexures of the earth's surface, rather than successive stages of subsidence due to gradual removal of a barrier of tidewater, or the gradual wear of a barrier of stone, does not rest on this single fact.

Even then he knew something of the change of levels in the Ontario Basin, for he immediately says, in citing other similar facts: "There is evidence that Lake Ontario, at Rochester, N. Y., has stood 70 feet lower than it does now" (p. 552). Some sentences in the same connection illustrate his capacity for generalization:

> While these facts abundantly prove that a simple theory of gradual drainings, by the elevation en masse of the lake regions, is entirely inadequate, they are too fragmentary to define clearly the general synchronism and se-

[1] Part VII, pp. 485–499.

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quence of the local movements to which they testify. Nevertheless, it is something to have learned that the writhings of the surface of the earth, which has in the ages so many times remapped the continents, has also been the great immediate cause of the transformation of the great lakes, and that, continuing through the latest distinguishable geological epoch and its prolongation the historical, it has now ceased.

Dr. Newberry was the first geologist to recognize the ice barrier as the cause of the high-level waters in the Laurentian Basin, and it is interesting to find a footnote over his initials at the bottom of the same page (552), reading as follows:

In the discussion of these facts cited by Mr. Gilbert, and others of similar character, it should be remembered that the retreating glacier must have, for ages, constituted an ice dam that obstructed the natural lines of drainage, and may have maintained a high surface level in the water basin which succeeded it.

The substance of Gilbert's report in the 1873 volume of the Ohio Survey had previous publication by permission in the American Journal of Science in 1871.[1] An abstract was also printed in the proceedings of the New York Academy of Sciences of February 20, 1871 (pp. 175–178).

In 1871 Gilbert joined the Wheeler survey of the western Territories and began the many years of work in the far West. From 1875 he was on the survey under Maj. Powell. The United States Geological Survey was organized in 1879 with Clarence King as Director, and young Gilbert became a member. From that time to his death, May 1, 1918, he was continuously on the national survey.

Gilbert was not a prolific writer, as compared with others and judged by his work and ability. Down to 1891 the bibliographic list carries 70 titles, 4 of which have associated authors. His initial publication, in recognized geologic mediums, was in 1871, on the Cohoes mastodon in the Twenty-first Annual Report of the New York State Cabinet of Natural History. His next three articles have been noted above, relating to Ohio geology and the ancient beaches. From 1871 his papers are mostly in description of features of the western country. The most important of his earlier papers is the report on the Henry Mountains, published in 1877. In this classic paper he described a new type of mountains, now fully recognized. These were originally domes, or areas of sedimentary strata lifted by the injection of lava from beneath. Quoting his own description, page 19:

The lava of the Henry Mountains behaved differently. Instead of rising through all the beds of the earth's crust, it stopped at a lower horizon, insinuated itself between two strata, and opened for itself a chamber by lifting all the superior beds. In this chamber it congealed, forming a massive body of trap. For this body the name laccolite (cistern stone) will be used.

In later years the name has been changed to laccolith. Subsequent erosion of these uplifts by doming has often destroyed the arching

[1] Vol. 1 of third series, pp. 339–345.

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form or obscured the primitive shape and exposed the injected igneous heart. The latter part of this book is a discussion of land sculpture. In this statement of the principles of erosion and the origin of topographic forms he shares with Newberry and Powell the honor of a pioneer.

Probably his most famous writing is the work on Lake Bonneville. This is the initial volume of the series of quarto monographs published by the National Survey and bears the date of 1890. This describes the wide expanded predecessor of the present Great Salt Lake, which existed in glacial time when humidity and rainfall of the Great Basin produced the vast lake which overflowed northward to the Columbia River. Great Salt Lake is only the saline remnant of that desiccated fresh-water body.

This handsome quarto volume contains a chapter on "Topographic features of lake shores," which is the classic writing on shore-line topography.

It is interesting to note that he published no articles relating to the Rochester region until after his long period of western exploration. His first publication in reference to the Ontario basin was in 1885, on the Iroquois shore line; although he then called it simply the old shore line of Ontario. Between then and 1891 he published six papers on the Pleistocene features or glacial history of the Ontario basin; and one on the sink ridges near Caledonia.

From 1892 to 1900, eight years, his list of writings is 40; covering a wide range of subjects in geology. Of these 8 related to western New York. From 1901 to 1905 25 titles are on record, of which only 2 concern western New York. During 1906 and 1907 he published 9 articles, one being on Niagara. In 1908 only four articles, including another on Niagara, are recorded in the bibliography. Since 1908 only five titles are credited. All together this makes 156 titles, of which 18 relate to the geology of western New York or the Ontraio basin.

The few papers published in later years is explained by his poor health, due to a slight stroke of apoplexy. After this time by very careful living he was able to do some work in a deliberate way. His latest study was the transportation of detritus by streams, with reference to hydraulic mining in California. This work, spread over several years, was published last year, being his last publication. It is entitled "Hydraulic-mining Debris in the Sierra Nevada," and is Professional Paper 105 of the survey list, forming a quarto of 154 pages, with numerous maps and reproduction of photographs.

Dr. Gilbert's only writing for school textbooks is his Introduction to Physical Geography, in collaboration with Prof. A. P. Brigham. This was published in 1892 by D. Appleton & Co.

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Geology is so broad and comprehensive and so inviting in many directions that some men with active minds and lively interest scatter their studies over diverse fields. Dr. Gilbert more wisely confined his work to physical geology, especially geodynamics, in which he was recognized as a master. He published practically nothing in biologic geology or paleontolgy; and almost nothing in stratigraphy and petrology.

His geologic interest in his home region was mainly in glacial problems, especially the glacial lake Iroquois and the deformation of the Ontario basin. He was the first geologist to appreciate the complexity of the Pleistocene history of the valley. As early as 1885 he recognized the three controlling factors: (*a*) The damming effect of the waning glacier and the glacial nature of the earlier waters; (*b*) the succession of water levels due to opening of different outlets or places of escape for the impounded waters, by the recession of the glacier front; and (*c*) the dislocation and canting of the water planes by the tilting uplift of the land. His accurate conclusions regarding the complex history are embodied in a number of short papers, and especially in a chapter in the Sixth Annual Report of the Commissioners of the State Reservation at Niagara for the year 1890. The title of this important but little-known paper is "The History of Niagara."

Dr. Gilbert's mind was of the reflective philosophic type. He sought for the explanation and relationship of phenomena. His calm judgment and clear discrimination joined to a spirit of fairness and with gentle manners caused him to be much sought as a critic and helper. He was a sort of father-adviser to the members of the survey. Doubtless much of his thought has found expression in the writings of the younger men, who revered and loved him. The writer of this appreciation never heard him say a harsh word of anyone. He was reserved in personal matters, but it is known that the death of a young daughter affected and saddened his life. His wife, who was Fannie L. Porter, died over 20 years ago. Two sons are living.

Dr. Gilbert received many honors. The University of Rochester gave him the master's degree in 1872 and the doctor of laws degree in 1898. The latter degree was also conferred by the University of Wisconsin. He was the fourth president of the Geological Society of America, in 1892, and was again president in 1909, the only man honored by a second term. In 1899 he was president of the American Association for the Advancement of Science, probably the highest honor in the gift of American science. Naturally he was active and prominent in the scientific societies of the National Capital, and was a member of the National Academy of Sciences. He was one of the

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very few honorary members of this society.[1] In 1892, when the American Association for the Advancement of Science held its annual meeting in Rochester, this academy held a special meeting in Music Hall complimentary to the association, and the lecture of the evening was given by Gilbert, the subject being "Coon Butte and the theories of its origin." The relief map which he used on that occasion was donated to the university museum. It may be said that this was one of the very few times in which his theory has been proven wrong.

On the approach of his 75th anniversary, the 6th of last May, his friends were asked to send to the survey letters of appreciation, to be handed to him on that day. Unhappily he passed away on the 1st of the month at Jackson, Mich.

(Extract from SCIENCE, n. s., vol. 48, No. 1233, Aug. 16, 1918, pp. 151–154.)

In the Journal of Geology Prof. Thomas C. Chamberlin pays the following editorial tribute to the late Dr. Gilbert:

"The passing of Dr. Gilbert after almost 75 years of activity deprives geological science of one of its ablest and most honored representatives. It is permitted to few men to leave an equally enviable record. To an unusual degree his work was distinguished by keenness of observation, by depth of penetration, by soundness in induction, and by clarity of exposition. It is doubtful whether the products of any other geologist of our day will escape revision at the hands of future research to a degree equal to the writings of Grove Karl Gilbert. And yet this is not assignable to limitation of field, or to simplicity of phenomena, or to restriction in treatment. The range of his inquiries was wide; his special subjects often embraced intricate phenomena, while his method was acutely analytical and his treatment tended always to bring into declared form the basal principles that underlay the phenomena in hand.

"In the literature of our science the laccolith will doubtless always be associated with the name of Gilbert. In its distinctness as a type, in its uniqueness of character, and in the definite place it was given at once by common consent, one may almost fancy a figurative resemblance between the laccolith and its discoverer and expositor. Gilbert's monographs on the Henry Mountains and on Lake Bonneville will long stand as unexcelled models of monographic treatment. His contributions to physiographic evolution, particularly his analysis of the processes that end in base-leveling, link his name with that of Powell and give to these two close friends a unique place as joint leaders in interpreting morphologic processes. Glacial and hydraulic phenomena were also fields in which Gilbert's powers as an investigator and expositor were signally displayed.

[1] Rochester Academy of Sciences.

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"In accuracy of delineation, in clearness of statement, and in grace of diction Gilbert's contributions are certain long to stand as models of the first order. His personality was of the noblest type; he was a charming companion in the field; he was a trusted counselor in the study. The high place he has held in the esteem of coworkers is quite certain to merge into an even higher permanent place to be accorded him by the mature judgment of the future."

(Extract from Science, n. s. July 19, 1918, p. 65.)

SAMUEL WENDELL WILLISTON.

By J. M. ALDRICH, West Lafayette, Ind.

Samuel Wendell Williston, the eminent paleontologist and dipterist, died in Chicago on August 30, 1918. At the time of his death and for some years previous he was professor of paleontology and director of the Walker Museum in the University of Chicago.

He was born in Boston on July 10, 1852, and was therefore a little past 66 years old. His father was a blacksmith, uneducated but of native ability, who removed with his family to Manhattan, Kans., in 1857. Here young Williston's boyhood was spent, and in due time he entered the agricultural college in his home town, graduating from it in 1872. But his college course was interrupted, for he ran away from home at 18 and went to work as a railroad laborer, from which humble position he rose before he was 20 to be a transit man at a handsome salary for that time. However, he suffered greatly from malaria, and had to resign and go back home; after recuperating he finished his college course. Railroad engineering went flat in the panic of 1873, and he began to study medicine, "reading" in the office of a local doctor. In the summers of 1874 and 1875 he assisted Prof. B. F. Mudge on fossil collecting expeditions in western Kansas, the work being done for Prof. Marsh, of Yale University. He spent the winter of 1875–76 in the medical school of the University of Iowa, and was invited to come to Yale to see Marsh in the spring; this resulted in a contract to work for Marsh for three years at $40 a month, and in all to almost continuous employment with him for nine years, until 1885. He managed to finish his medical course and get his M. D. at Yale in 1880. But by this time his scientific bent was strongly developed, and it soon appeared that his work lay in following it rather than in the practice of medicine. He specialized in paleontology, and received his Ph. D. under Marsh in 1885. His genius for anatomy led to an appointment as demonstrator in Yale Medical School the following year, and after a short apprenticeship to the full professorship in human anatomy in 1887—a striking recognition of his ability.

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After three years in this position he accepted a call to the University of Kansas in 1890 as professor of historical geology and paleontology. Twelve years of his prime were spent in this institution—years crowded with productive labor. He helped organize the medical department of the university, and took on the deanship of it along with his other work; this almost broke his vigorous health, and he had to slacken his pace—perhaps never again quite regained it.

The consciousness that he was working beyond his strength had something to do with his going to the University of Chicago in 1902 as professor of paleontology. Here he was able to concentrate on a single specialty, officially at least, as he left medicine behind and thought he had left entomology also. In this place he spent the last 14 years of his life, beginning under some unexpected handicaps and gradually working up to full recognition and honor.

In the outline just given entomology is hardly hinted at, for the reason that Williston never held an official entomological position. But he found time to do much valuable work as a pioneer in dipterology. His employer would not allow him to publish in paleontology, and he sought a field outside where he could be free to work and publish; this he found in the Diptera. His interest in the flies began to be serious about 1878. At this time Osten Sacken had returned to Europe, and there was not a single American student of the order but Edward Burgess, the Boston yacht designer, who published only one small paper. So Williston was virtually alone on the Continent. In the absence of guidance, he plowed his way by main strength (as he often narrated to the writer) through descriptions of species until here and there he made an indentification, which served as an anchor point for a new offensive. He had few definitions of genera, so had to work backward from the species. After a year or two of this tedious and time-wasting effort he came upon Schiner's Fauna Austriaca, in which the Austrian families, genera and species of Diptera, as known up to 1862–1864, are analytically arranged and succinctly described. To his immense relief and satisfaction, he now found that all his American flies could be traced to their families, and most of them to their genera, in this fine work. He was so impressed by the saving of time accomplished that his own publications coming later show the effect of this early experience on every page; everywhere he has the beginner in mind and is clearing the way for him.

In a few years he began publishing tentative papers analyzing the American families and genera of the flies. These he extended and enlarged in a pamphlet in 1888, and again in a bound volume in 1896; and in 1908 published a third edition still more complete, with 1,000 figures, his well-known Manual of Diptera. This third

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edition is his main contribution to entomology. It is a handbook unapproached by anything else dealing with a large order of insects. From necessity he published it at his own expense; it was eight years before the receipts from sales covered the cost of printing, but happily he lived to see this consummation.

His other papers of his early period, 1881–89, dealt with Asilidae, Conopidae, Tabanidae, and smaller groups, and especially with Syrphidae, in which his fine monograph of 1886 is still in universal use, and by the taxonomic genius of its author has created in the United States an ineradicable belief that the family is an easy one, well adapted for the beginner to publish in, a mistaken belief, but highly complimentary to the monographer.

From 1890 his more important papers were concerned with tropical Diptera (Mexico, St. Vincent, Brazil) and with bibliography. As his official duties grew more exacting he gradually abandoned entomology, but he had as many farewell appearances as an opera singer, for he could not resist the temptation to come back again and again. Even as late as the spring of 1917, when he was visiting the writer and reveling once more in a collection of Diptera, his old enthusiasm came back so strongly that he planned describing some new genera, and did in fact publish one (Annals Ent. Soc. Amer., x, 23). But after 1896 he did little work on the order except in preparing the third edition of his Manual, which cost him two years of arduous work, as he drew 800 figures with his own hand. His deep interest in genera and his very wide acquaintance with them, together with his universally recognized taxonomic ability, made him in the period 1890–1900 the peer of Osten Sacken, Brauer, and Mik as a world authority in Diptera.

The types of Williston's new species are much scattered. His Syrphidae were acquired by the National Museum; the rest of his earlier collections by the University of Kansas; his Biologia material and that from St. Vincent went to London and, I understand, were finally deposited in the British Museum; the American Museum of Natural History obtained his later collections, including some duplicates of type series from St. Vincent and perhaps Mexico. Williston did not believe in designating a single-type specimen, hence in some cases his types of the same species are in two museums. He had no collection of Diptera in his last years, although he still retained his fine library in the order.

Although he never gave any formal entomological courses, he gave informal and even more valuable assistance both in Kansas and Chicago to several entomologists who were specializing on Diptera, among them W. A. Snow, Hugo Kahl, C. F. Adams, A. L. Melander, and myself. We all admired him and our admiration grew into deep love and veneration with the passing years. He had students outside

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of entomology like E. C. Case and C. E. McClung, who achieved high scientific standing. His lecture courses in palaeontology were full of broad generalizations about evolution and in the highest degree stimulating and profitable to students with biological training, as I am informed by Melander, who took them. He did not have large classes at any time and his lectures were mostly informal in style, drawn from a rich experience and given in intimate association with the student, the kind that would make a deep impression. But his life work was mainly directed to the larger circle outside his institution.

While in New Haven he received a visit from C. V. Riley, who urged him to come to Washington as first assistant in the Division (afterwards Bureau) of Entomology. But Williston entertained a shrewd doubt as to whether he could be happy in a position subordinate to Riley, and declined the offer, although its acceptance would have meant a permanent position at an increased salary. This incident was narrated to me several times by Williston; it occurred about 1885.

In the last few years Williston published two volumes on fossil reptiles, his greatest specialty, and last winter was working on a handbook of reptilia, which was probably near completion when he was compelled to abandon it. If this volume can be printed, it will close up his work on the reptiles about as well as his Manual of Diptera did for the flies. My last mental picture of the man represents him on a day last winter, sitting at a table before a window in his study at home, in one hand a long-snouted reptilian skull, in the other a drawing pen, with which he was rapidly making a sketch of it.

He attended the Pittsburgh meeting of the Entomological Society of America last winter and gave reminiscences of his early work on Diptera to an interested audience.

In physique he was large and vigorous, and mentally he was greatly endowed. I think I shall offend no living American dipterist when I say that he towered above us all. The truth of the assertion will be more clearly evident if we consider that his work on Diptera was never more than a side line, an absolute gift to science, accomplished in odd times while he was attaining distinction in anatomy and world-wide reputation in palaeontology, his main specialties.

Considering the positiveness of his opinions and his frankness in expressing them, his life was singularly free from scientific controversies, and especially from those leading down into personalities. In many long conversations with him, I do not recall that I ever heard him express a personal dislike for a scientific colleague, except in one case where he felt that advancement in a teaching position had been obtained by servility, and another where he felt that his own matured opinion had been treated rather contemptuously.

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His last years were full of honors. He was a delegate to the International Zoological Congress at Monaco; Yale University gave him an honorary D. Sc.; he was chosen to the limited membership of the National Academy of Sciences, and the Entomological Society of America made him an honorary fellow, one of 7 out of its membership of 600.

He was married in 1880 to Annie I. Hathaway, of New Haven, who survives him, together with three daughters and a son.

I first knew him by correspondence in 1890, when on learning that I was beginning to work on Diptera he sent me separates of his papers. In January, 1893, I went to the University of Kansas to study, drawn entirely by his presence there. He received me with open arms, and helped me in every way possible until I left in July to take up my work in Idaho. Then I saw him only a time or two in 20 years, and had few and short letters from him, for he was a notably poor correspondent. After coming to Indiana in 1913 I was so near that we were frequently together. My sketch would be entirely inadequate without some acknowledgment of my personal obligation. In Kansas he lent me money; he wanted me to live in his house; he could not do enough to further my scientific aspirations. More than any other of my teachers, he became my ideal of a scientific man; and if in later years my ideal took on larger proportions, so he, too, seemed to expand in his mature powers; and at the close of his life I still feel that a splendid and inspiring example of scientific work and achievement is contained in his career.

(Extract from Entomological News, vol. 29, Nov., 1918, pp. 322–327.)

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THIRD ANNUAL REPORT OF THE NATIONAL RESEARCH COUNCIL.

The sudden collapse of the central powers, and the consequent swift transition from war to peace conditions, fortunately did not take the National Research Council wholly unawares. From the time of its initiation in 1916, the Council has always recognized that its chief service could be best performed in times of peace, and the definition of its functions contained in the Executive Order issued by President Wilson on May 11, 1918, relates particularly to this possibility. Moreover, throughout the period of the war, when all of the divisions of the Council were organizing and promoting research to meet military and naval needs and to solve industrial problems of an emergency nature, the question of future activities and the provision of an organization adequate to deal with them were constantly in view. Since the signing of the armistice the chief work of the Council has been to utilize the various preliminary studies made during the war period for the formulation of a definitive scheme of organization and a plan of work in keeping with the heavy demands which existing conditions entail.

Apart from its numerous war activities, outlined in the present report, and to be treated subsequently in greater detail, the leading matters of interest in the progress of the Council during the past year are the Executive Order of President Wilson, the development of the work of the Research Information Service, the organization of the International Research Council, the report of the Patent Committee, the work of the Industrial Research Section, and the preparation of a plan of permanent organization. Before dealing with the reports of divisions on war problems, these phases of the Council's activities will be described.

THE PRESIDENT'S EXECUTIVE ORDER.

The congressional charter of the National Academy of Sciences provides that "the Academy shall, whenever called upon by any department of the Government, investigate, examine, experiment, and report upon any subject of science or art." Under this provision the Academy has acted since the time of its establishment as an official adviser of the Government on a wide variety of questions. During the Civil War, as the earlier records of the Academy indicate, its com-

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mittees and its members dealt actively with military and naval problems of precisely the same type as those which have insistently pressed for solution during the present war. It was thus a natural step on the part of the Academy to offer its services to the President at a time, in April, 1916, when our relations with Germany were already tense, and for the President to accept the offer, and to request the Academy to organize the scientific and technical resources of the country in the broadest and most effective manner, to accomplish the objects in view. He recognized clearly, as the Academy also had perceived, that new and important possibilities had been opened through the heavy demands upon science and research which had arisen through the exceptional necessities brought about by the war.

In accepting the President's request, and in taking the steps that soon led to the establishment of the National Research Council, the Academy, fortified by its charter, waited for no more formal expression than that conveyed by the President's oral statement. But as the work of the Research Council progressed, it became evident that a definite formulation of its objects by the President, and an expression of his desire that it be perpetuated by the Academy and permanently assured of the cooperation of the various departments of the Government, would serve a useful purpose. The President's recognition of this fact led him to issue the following Executive Order on May 11, 1918:

NATIONAL RESEARCH COUNCIL.

EXECUTIVE ORDER ISSUED BY THE PRESIDENT OF THE UNITED STATES.

The National Research Council was organized in 1916 at the request of the President by the National Academy of Sciences, under its congressional charter, as a measure of national preparedness. The work accomplished by the Council in organizing research and in securing cooperation of military and civilian agencies in the solution of military problems demonstrates its capacity for larger service. The National Academy of Sciences is therefore requested to perpetuate the National Research Council, the duties of which shall be as follows:

1. In general, to stimulate research in the mathematical, physical, and biological sciences, and in the application of these sciences to engineering, agriculture, medicine, and other useful arts, with the object of increasing knowledge, of strengthening the national defense, and of contributing in other ways to the public welfare.

2. To survey the larger possibilities of science, to formulate comprehensive projects of research, and to develop effective means of utilizing the scientific and technical resources of the country for dealing with these projects.

3. To promote cooperation in research, at home and abroad, in order to secure concentration of effort, minimize duplication, and stimulate progress; but in all cooperative undertakings to give encouragement to individual initiative, as fundamentally important to the advancement of science.

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4. To serve as a means of bringing American and foreign investigators into active cooperation with the scientific and technical services of the War and Navy Departments and with those of the civil branches of the Government.

5. To direct the attention of scientific and technical investigators to the present importance of military and industrial problems in connection with the war, and to aid in the solution of these problems by organizing specific researches.

6. To gather and collate scientific and technical information at home and abroad, in cooperation with governmental and other agencies, and to render such information available to duly accredited persons.

Effective prosecution of the Council's work requires the cordial collaboration of the scientific and technical branches of the Government, both military and civil. To this end representatives of the Government, upon the nomination of the President of the National Academy of Sciences, will be designated by the President as members of the Council, as heretofore, and the heads of the departments immediately concerned will continue to cooperate in every way that may be required.

WOODROW WILSON.

THE WHITE HOUSE, *May 11, 1918.*

Supplementing, as it does, the charter of the Academy, and serving as a permanent request for the exercise of such functions as the National Research Council has been able to render, this Executive Order points the way for the future work of the Council.

RESEARCH INFORMATION SERVICE.

One of the functions of the Research Council, as stated in the Executive Order, is "to survey the larger possibilities of science, to formulate comprehensive projects of research, and to develop effective means of utilizing the scientific and technical resources of the country for dealing with these projects." The Research Information Service, inaugurated in cooperation with the Intelligence Services of the Army and Navy, and represented in London, Paris, and Rome by scientific attachés and their associates connected with the American embassies, is the first requisite in preparing such broad surveys. Properly regarded, this Information Service may be considered as the pioneer corps of the Council, surveying the progress of research in various parts of the world, selecting and reporting upon many activities of interest and importance, reducing the information thus collected to such a form as to render it most accessible and useful, and disseminating it to scientific and technical men and to institutions which can use it to advantage.

But the work of the Service must not end here. Its duties necessarily involve the collection of much detailed information; but to accomplish the larger objects of the Council its attention must not be confined solely to matters of detail. Out of this great mass of information, and out of the work of the various divisions of the Council, acting in cooperation with the Research Information Service,

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there must come broad surveys of the larger possibilities of research, indicating opportunities likely to be missed by the investigator concerned with limited branches of science, and pointing the way to the occupation of many fields where great return may be expected to result from well-organized effort.

It therefore goes without saying that the position of scientific attaché at our principal embassies, created during the war in connection with the Research Information Service, should undoubtedly be continued during times of peace. The scientific attaché acts in conjunction with the military and naval attachés, who are glad to intrust him with many of their technical problems. Such problems will frequently arise in the future as they did in the period preceding the war. But the duties of the scientific attaché are evidently not confined to questions of war, which, indeed, can not be distinguished in most cases from the problems of peace. Nitrates, no longer needed for explosives, are now no less urgently demanded for fertilizers. Optical glass, if not required for gun sights and periscopes, is wanted in large quantities for field glasses, microscopes, medical instruments, and scores of other purposes. Metallurgical processes, improved for the manufacture of guns and helmets, must give us flawless rails for security in travel, better electrical conductors, and other essentials. In short, almost all of the subjects in which the scientific and technical men of the allies have exchanged research information during the war demand similar cooperation under peace conditions. In view of these facts, the International Research Council, at its first meeting in Paris, adopted the following resolution:

The International Research Council, assembled in Paris and attended by delegates of the national academies of sciences of Belgium, Brazil, the United States, France, Great Britain, Italy, Japan, Poland, Portugal, Rumania, and Serbia, has the honor to request the Governments of these countries to appoint permanent scientific attachés at their principal embassies. The function of the scientific attachés shall be to collect and forward information regarding scientific and technical matters, and to insure the continuity of the relations established during the war by the various scientific and technical missions.

In addition to the services already mentioned, the scientific attaché would serve as the general representative of American scientific and technical interests in the country to which he may be accredited; attend scientific meetings and keep in touch with the progress of research, reporting frequently to Washington; maintain his office as a center for American scientific and technical men and missions desiring to make contact with the scientific men or institutions of the country; undertake special tasks and make particular reports on questions submitted by properly accredited individuals or institu-

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tions; and contribute in other ways toward international cooperation in research.

On December 3, 1917, the military committee of the National Research Council adopted resolutions providing for the creation of the Research Information Committee and outlining its functions. These resolutions were submitted to the National Research Council for approval and for transmission to the Council of National Defense. On December 12, the Council of National Defense approved the project, and Dr. S. W. Stratton was appointed chairman of the committee, which included the Chief of Military Intelligence and the Director of Naval Intelligence. The organization proceeded rapidly from that time. An appropriation of $38,000 was made from the President's fund to cover the first year's expenses of the Washington, London, and Paris offices, and Dr. H. A. Bumstead and Dr. W. F. Durand sailed early in February to assume their duties as scientific attachés at the London and Paris embassies, respectively. Early in May, the Italian Ambassador addressed a request from his Government to the Secretary of War, asking that an office of the Research Information Committee, similar to those in London and Paris, be established in Rome. After some delay this was authorized, and an additional appropriation was made to cover the expense of the new office. Mr. S. L. G. Knox was appointed scientific attaché at Rome by the chairman of the National Research Council, and sailed in July to assume his duties there.

After the successful operation of the committee for several months, it began to appear that expansion of the organization was desirable, and the following order was issued by the Secretary of War on July 2, directing that an officer from each of the military bureaus be appointed to represent his respective bureau on the committee.

WAR DEPARTMENT,
THE ADJUTANT GENERAL'S OFFICE,
Washington, July 2, 1918.

From: The Adjutant General of the Army.
To: The National Research Council, Washington, D. C.
Subject: Information section, Ordnance Department, and Research Information Committee.

1. The Secretary of War directs that you be informed as follows:

2. The Research Information Committee was formed to establish machinery by means of which the General Staff of the Army, the various bureaus of the Army and Navy, the scientific organizations in the United States who are working on problems connected with war production and invention, and the various committees of the Council of National Defense charged with work of this nature, may be put in touch with the developments and experimental work being carried on, not only in this country but in Europe, and kept mutually informed of the state of development of work of this nature.

3. In pursuance of the order of the Secretary of War, establishing this committee and in order effectively to do this work, it is vitally necessary that the

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utmost of cordial cooperation be shown by each of the bureaus and committees in question with the Research Information Committee. To secure this the following is directed:

(*a*) All military bureaus requiring scientific and technical information are given official status on the Research Information Committee in Washington, D. C.

(*b*) Representatives of military bureaus or of research committees collecting information abroad will be instructed, by their chiefs, to put themselves into direct relationship with the joint committees of the Research Information Committee sitting in Paris or London, or later in Rome, in order that information be at once dispatched to the Research Information Committee at Washington, D. C. All communications of scientific investigations or research shall be routed through these channels, even though other channels are employed at the same time.

(*c*) Official means of intercommunication, such as memorandums, bulletins, and the like, between bureaus of the Army and committees for research shall be developed to such a degree of efficiency by the Research Information Committee that the distribution of information shall be practically automatic.

(*d*) Before sending officers or civilians abroad for investigation work, all Army bureaus or civilian research committees shall get in touch with the Research Information Committee at Washington, D. C., for information and guidance.

(*e*) The present method of routing information memoranda for file and distribution through the Military Intelligence Branch will not be discontinued.

(*f*) You will immediately notify this office and the Research Information Committee of the name of the officer who shall represent your bureau before the Research Information Committee.

BY ORDER OF THE SECRETARY OF WAR:

(Sgd.) PAUL GIDDINGS, *Adjutant General.*

In accordance with the principles of this order of the Secretary of War, the Research Information Committee was reorganized and its name changed to the Research Information Service. In addition to the military representatives appointed in accordance with the order of the Secretary of War, representatives of naval bureaus and of certain civil bureaus of the Government were also appointed. The new organization which thus resulted may be found on page 103.

The work of the Washington office of the Service during the war included the sending of scientific and technical information to our scientific attachés abroad, the distribution of reports from foreign offices, the cataloguing and filing of reports, and such miscellaneous services as the introduction to our scientific attachés abroad of officers and civilians going to Europe to collect information, and the utilization of various means of making the information collected of general use to the Army and Navy and to other agencies engaged in the investigation of war problems. In addition to the numerous reports and the other information sent abroad, various special pieces of apparatus have been secured and forwarded in answer to specific requests, including a complete device for the training of gun pointers, sets of special signalling apparatus, vacuum apparatus required by the British Ministry of Munitions, and numerous small articles, such

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as luminous zinc sulphide, special aviators' goggles, ear valves, Aldis sights, camera mountings, etc.

One of the most important phases of the work of the Washington office has been the distribution of reports received from the foreign offices. The nature of these reports has been extremely varied, covering practically every field of activity on war problems. To indicate some of the subjects included, and also to illustrate the fact that many of these reports are on subjects which are quite as important under peace conditions as during the time of war, the following summary will be of interest:

	Reports from abroad.	Index cards (approximately).
Aeronautics:		
Airplanes	330	2,000
Balloons, dirigibles	54	350
Ordnance:		
Antiaircraft	30	150
Bombs	44	350
Explosives	32	240
Miscellaneous	26	200
Submarine detection	116	600
Toxic gas warfare	20	400
Location by sound	38	160
Signaling	22	200
Camouflage	17	100
Chemistry	106	400
Metals	72	360
Photography	29	250
Medical	21	200
Radio	15	320
Gasoline engines	21	160
Searchlights	11	150
Optical miscellaneous	14	100
Miscellaneous	83	1,000
Total	1,101	7,690

Much of the information included in the last half of this table, and many of the reports relating to aeronautics, are of value for peace purposes as well as for those of war.

Most of these reports have been either "confidential" or "secret," and their distribution has entailed the greatest care on the part of the office personnel. The obvious idea has been that these reports should be received by all persons in the Government service officially concerned in them, and that they should not be sent to persons not properly concerned in them. As the number of reports received from abroad increased it was found desirable to inaugurate a limited circulation of confidential memoranda containing titles of the reports

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received, together with a brief statement of the nature and content of the reports. Subsequent to the reorganization of the Research Information Service, copies of these memoranda, complete from the beginning, were sent to each official representative of military, naval, and civil bureaus, and these were supplemented regularly by the issue of memoranda relating to new reports. With the aid of such memoranda each bureau was informed of the existence and nature of reports in which they might be officially interested and which might not have reached them from other sources. Copies of the full reports were then furnished on request of the bureaus. In this way nearly 1,200 copies of reports, many of them of considerable length, have been prepared and distributed.

The numerous activities of the foreign offices of the Research Information Service, unfortunately, can not be reported upon in detail here, but more complete information regarding them will be given later. No mention of these offices can be made, however, without an expression of our appreciation of the cordial cooperation of our embassies, of the naval and military officers of the American forces, and of all representatives, military, naval, and civil, of the British, French, and Italian Governments. The extremely cordial attitude of Admiral Sims, in command of United States naval forces operating in European waters, is best illustrated by the following order, creating a scientific division of his staff, placing the scientific attaché in London at its head, and calling for the full cooperation of the officers connected with our vessels abroad:

UNITED STATES NAVAL FORCES OPERATING IN EUROPEAN WATERS,
U. S. S. "MELVILLE," FLAGSHIP,
London, England, April 16, 1918.

CIRCULAR LETTER NO. 21.

Subject: Joint Information Committee.

1. Since the beginning of the present war, and particularly since the entry of the United States into the war, various departments of the Government, associations, societies, and clubs throughout the United States have sent representatives abroad for scientific and industrial research work, each department or other body acting independently and without reference to what the others were doing.

2. This practice has caused a considerable duplication of work, given great annoyance to those from whom the information has been obtained abroad, and has resulted in friction, inefficiency, and failure to achieve the most satisfactory results.

3. To correct this unsatisfactory state of affairs the Secretaries of War and of the Navy, by joint action, and with the approval of the Council of National Defense, authorized and approved the organization, through the National Research Council, of a joint information committee, to have its headquarters in Washington and to have branch committees in London and Paris. The branch committees are intended to work in close cooperation with the officers of the Military and Naval Intelligence Services.

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4. The functions of the branch committees in London and Paris are to secure, classify, and disseminate scientific, technical, and industrial research information (particularly such as relates to war problems) and to effect the interchange of such information between the allies in Europe and the United States.

5. The State Department has agreed to withhold passports from all scientific investigators except from those applicants who are duly recommended for passports by the joint information committee in Washington. It is the intention of that committee, before recommending the issue of a passport, to investigate carefully the necessity for the proposed research work, making sure that the information sought is not already on file and that the organization abroad is not in a position to obtain such information with its previously existing personnel.

6. All such investigators who are granted passports are to be regarded as representatives of the joint information committee and will be directed to report to the London committee upon arrival in England and to the Paris committee on arrival in France.

7. The joint committee sitting in Washington consists of the following:

(1) A civilian member, representing the National Research Council.

(2) The chief of the Military Intelligence Section.

(3) The director of Naval Intelligence.

8. The initial organization of the branch committees in London and Paris will be:

(1) A scientific attaché, representing the joint information committee.

(2) The chief of the Military Intelligence Section.

(3) The director of Naval Intelligence.

9. The scientific attachés at present are: London, Dr. H. A. Bumstead; Paris, Dr. W. F. Durand. Assistants to these attachés will presumably be sent from the United States from time to time, as the need for them becomes apparent. At present Mr. S. W. Farnsworth is at the London office as an assistant to Dr. Bumstead.

10. The chief functions of the branch committees are intended to be the following:

(*a*) The development of contact with all important research laboratories or agencies, governmental or private; the compilation of problems and subjects under investigation; and the collection and compilation of the results attained.

(*b*) The classification, organization, and preparation of such information for transmission to the joint information committee in Washington.

(*c*) The maintenance of continuous contact with the work of the offices of military and naval attachés in order that all duplication of work or crossing of effort may be avoided, with the consequent waste of time and energy and the confusion resulting from crossed or duplicated effort.

(*d*) To serve as an immediate auxiliary to the offices of the military and naval attachés in the collection, analysis, and compilation of scientific, technical, and industrial research information.

(*e*) To serve as an agency at the immediate service of the commander in chief of the military and naval forces in Europe for the collection and analysis of scientific and technical research information, and as an auxiliary to such direct military and naval agencies as may be in use for the purpose.

(*f*) To serve as centers of distribution to the American Expeditionary Forces in France and to the American Naval Forces in European Waters of scientific and technical research information originating in the United States and transmitted through the joint information committee in Washington.

(*g*) To serve as centers of distribution to our allies in Europe of scientific, technical, and industrial research information originating in the United States and transmitted through the joint information committee in Washington.

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(*h*) The maintenance of the necessary contact between the officers in London and Paris, in order that provision may be made for the direct and prompt interchange of important scientific and technical information.

(*i*) To aid research workers or collectors of scientific, technical, and industrial information from the United States, when properly accredited from the joint information committee in Washington, in best achieving their several and particular purposes.

11. The scientific attaché in London, with his assistants, has been given office space and facilities at the force commander's London headquarters, and is regarded as a member of the force commander's staff. It is desired and directed that all officers of the staff facilitate in every possible way the performance of the work of the scientific attaché, and that they keep him informed as to the classes of information or scientific investigation that would be most beneficial to them in their work.

12. Officers in the force at large are desired to furnish to the scientific attaché, through the force commander, any information of value of which they may be possessed and to make suggestions as to profitable lines of scientific investigation.

13. The branch committee in London, or the scientific attaché, as its representative, in distributing information as contemplated in paragraph No. 10 (*f*) above, will do so through the medium of the force commander as regards the naval forces and through such channels as the military attaché may prescribe as regards the military forces. The branch committee in Paris will forward information to the naval forces through the naval attaché, who will transmit it through the usual official channels.

14. In distributing information to our allies in Europe, as contemplated in paragraph No. 10 (*g*) above, the branch committees, or the scientific attachés as their representatives, will transmit the information through the military or naval attaché if it is intended for the military or naval departments of the foreign governments concerned; if it is intended for a civil department, it will be transmitted direct, but if it would be of use or interest to the military and naval forces it will be also transmitted to the military and naval commanders through the attachés.

15. In order to facilitate the work of the branch committees under paragraph No. 10 (*i*) above, it is desired and directed that the officers of the force commander's staff exert every proper effort to make sure that all investigators, whether officers or civilians, who come to London are put in touch with the scientific attaché in order that mutual assistance may be rendered and that a complete file of information may be maintained in the branch committee's office. All officers of the staff are furthermore directed, before initiating any new investigation, to consult with the scientific attaché to determine whether or not the desired information has been already acquired by the branch committee, and they will equally inform the scientific attaché of the results of any investigations they may make. All concerned must constantly bear in mind the necessity for avoiding duplication of work on the part of the various branches of the staff organization.

16. Officers attached to headquarters in Paris will be guided by the principles underlying the instructions contained in the preceding paragraphs.

(Signed) WM. S. SIMS,
Vice Admiral, U. S. Navy, Commanding and Naval Attaché, London.

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OFFICE MEMORANDUM NO. 61.

LONDON, *April 16, 1918.*

Subject: Scientific attaché.

1. The attention of all the staff is invited to Circular Letter No. 21, of April 16, 1918, regarding the joint information committee organized in Washington, with branch committees in London and Paris, and the scientific attachés.

2. While all officers are desired to keep in as close touch as possible with the work of the scientific attaché, it is particularly desirable that the following officers maintain the closest relations with him with a view to constant interchange of information:

(1) The officer having cognizance of submarine hunting by sound.

(2) The ordnance officer.

(3) The radio officer.

(4) The officer having cognizance of electrical matters.

(5) The medical officer.

3. The division of the staff headed by the scientific attaché will be known as the Scientific Division, and its symbol will be NS.

(Signed) N. C. TWINING,
Captain, U. S. Navy, Chief of Staff.

In addition to the advantages thus accorded to our scientific attachés, Admiral Sims furnished them with offices in both London and Paris, and contributed in many other ways to the convenience and efficiency of their work. Maj. Gen. John Biddle, commanding the American Expeditionary Forces in England, also issued a similar order and facilitated in many other ways the work of the scientific attaché. Similar courtesies were shown to our representatives in Paris and Rome, both by the Army and Navy. It thus appears that the cooperative plan involved in the organization of the Research Information Service has proved to be acceptable to all of the interests concerned, and that its continuation should be advantageous after such modifications have been made as will be necessary to render the service of the greatest use under peace conditions.

One of the chief objects now to be attained is to render the offices of the Service more effective as centers of information on scientific and technical questions. Existing agencies of such information, such as Government bureaus and the valuable library service of the American Society of Mechanical Engineers in New York, will be freely drawn upon. It is not the intention to duplicate such sources, but to secure their wider utilization. In addition to the fund of information available in its own offices, the Research Information Service will arrange to call upon competent correspondents in scientific and technical laboratories throughout the country, who will aid in supplying special information.

The work of organizing the Information Service for its new and larger duties is now proceeding under the direction of Dr. Robert M. Yerkes and with the assistance of Dr. G. S. Fulcher, who replaced Dr. Graham Edgar when the latter resigned his position on January

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27, 1919, after conducting the office with marked success throughout the greater part of the war.

ORGANIZATION OF THE INTERNATIONAL RESEARCH COUNCIL.

On June 17, 1918, the secretary of the Royal Society of London invited the National Academy to send delegates to an Interallied Conference on International Scientific Organizations, to open in London on October 9. The president of the Academy, after the matter had been given full consideration by the council of the National Academy of Sciences and the executive board of the National Research Council, appointed the following delegates from the Academy and Council: H. A. Bumstead, J. J. Carty, W. F. Durand, Simon Flexner, A. A. Noyes, and George E. Hale, chairman. All of these attended the conference in London, at which the following countries were represented by the delegates named below:

Belgium.—Georges Lecointe, J. Massart, Ch. de la Vallée Poussin.
Brazil—C. D. de Carvalho.
France.—B. Baillaud, G. Bigourdan, Albin Haller, A. Lacroix, Charles Lallemand, Charles Moureu, Emile Picard.
Italy.—Vito Volterra.
Japan.—Joji Sakurai, Aikichi Tanakadate.
Portugal.—Braamcamp Freire.
Serbia.—B. Popovitch.
United States.—H. A. Bumstead, J. J. Carty, W. F. Durand, S. Flexner, G. E. Hale, A. A. Noyes.
Great Britain.—Sir J. J. Thomson, Sir Alfred Kempe, A. Schuster, W. B. Hardy, W. A. Herdman, Sir F. Dyson, J. H. Jeans, H. G. Lyons, J. A. McClelland, Sir E. Sharpey Schafer, C. S. Sherrington, Sir W. Tilden.

The delegate nominated by the Government of Portugal did not arrive in England in time to take part in the conference.

A committee of the Royal Society issued a memorandum on international scientific organizations, in which it is pointed out that they "may be divided into four groups, according to their objects and methods of procedure. Some are intended to establish uniformity in the standards of measures, others to advance science by cooperation, and others again merely to encourage present interchange of opinion. Those that aim directly at organizing scientific progress may further be divided into two parts, according as the cooperation is essential to coordinate observations taken in different places or aims only at economy of labor." The memorandum then goes on to review the characteristics of a large number of international organizations and concludes with a statement of the following subjects for discussion at the conference:

1. Is it desirable for the allied nations to establish organizations for scientific cooperation among themselves?
2. If this be agreed upon, what should be the particular forms of organization to be aimed at in geodesy, seismology, meteorology, etc.?

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3. Should particular academies be asked to submit proposals on those undertakings in which they have taken the leading part, such as—

(*a*) The Académie des Sciences on the Commission Metrique and the Bureau International des Poids et Mesures.

(*b*) The Royal Society on the International Catalogue of Scientific Literature.

4. What representation should be addressed to the governments with regard to those organizations which have hitherto received their support?

DECLARATION.

The first act of the London conference was to define its attitude, as expressed in the following declaration, toward the question of future relations with the men of science of the central powers:

When more than four years ago the outbreak of war divided Europe into hostile camps, men of science were still able to hope that the conclusion of peace would join at once the broken threads and that the present enemies might then once more be able to meet in friendly conference, uniting their efforts to advance the interests of science. For ever since the revival of learning in the middle ages the prosecution of knowledge has formed a bond strong enough to resist the strain of national antagonism. And this bond was strengthened during the latter part of last century, when branches of science developed requiring for their study the cooperation of all the civilized nations of the world. International associations and conferences rapidly multiplied and the friendly intercourse between the learned representatives of different countries grew more intimate in spite of their political differences, which were admitted but not insisted upon.

In former times war frequently interrupted the cooperation of individuals without destroying the mutual esteem based on the recognition of intellectual achievements; peace then soon effaced the scars of a strife that was ended. If to-day the representatives of the scientific academies of the allied nations are forced to declare that they will not be able to resume personal relations in scientific matters with their enemies until the central powers can be readmitted into the concert of civilized nations, they do so with a full sense of responsibility and they feel bound to record the reasons which have led them to this decision.

Civilization has imposed restrictions on the conduct of nations which are intended to serve the interests of humanity and to maintain a high standard of honor, such as the recognition of the sanctity of treaties, especially those designed to apply to a state of war, and the avoidance of unnecessary cruelties inflicted on civilians. In both these respects the central powers have broken the ordinances of civilization, disregarding all conventions, and unbridling the worst passions which the ferocity of war engenders. War is necessarily full of cruelties; individual acts of barbarity can not be avoided and have to be borne. It is not of these we speak, but of the organized horrors encouraged and initiated from above with the sole object of terrorizing unoffending communities. The wanton destruction of property, the murders and outrages on land and sea, the sinking of hospital ships, the insults and tortures inflicted on prisoners of war, have left a stain on the history of the guilty nations which can not be removed by mere compensation of the material damage inflicted. In order to restore the confidence without which no scientific intercourse can be fruitful, the central powers must renounce the political methods which have led to the atrocities that have shocked the civilized world.

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INTERNATIONAL RESEARCH COUNCIL.

On behalf of the council of the National Academy of Sciences, the delegates of the Academy submitted to the conference the following proposal:

SUGGESTIONS FOR THE INTERNATIONAL ORGANIZATION OF SCIENCE AND RESEARCH.

1. Immediate importance of International Organization to meet war needs.—The experience of men of science since the outbreak of the war has strongly emphasized the fact that there has never been an international association adequate to represent the larger interests of science and research. The International Association of Academies had within it the germs of better things, and some of us have attended its meetings for years in the hope that it might ultimately be developed into a thoroughly effective organization. Its chief merit lay in the inclusion of the principal national academies of sciences, which should certainly play a leading part in any international organization relating to science as a whole. Its defects were more numerous, involving among others the exclusion of many elements vital to the promotion of the best interests of research, together with an almost complete cessation of activity during the three-year intervals between successive meetings. Since the Petrograd meeting of 1913, when the possibility of greater usefulness was freely discussed, the association has practically ceased to exist.

Current events clearly indicate, however, the great importance of establishing an international body for promoting the general interests of science and research. The special needs of geodesy, chemistry, engineering, seismology, medicine, astronomy, and other branches of science and technology are no less urgent than before, and the various international bodies formed to deal with them should be reorganized to meet existing conditions. But the broader necessities of science and research, seriously threatened through loss of men and curtailment of revenue, but potentially strengthened through a greatly enhanced public appreciation of their national importance, call for a new and vigorous movement in their behalf. This should be initiated at once by the nations of the Entente, primarily with reference to war needs, but with the expectation that in the future other nations, not now in a position to cooperate, will be invited to take part.

2. New factors in the organization of research emphasized by recent experience.—Experience in the United States since our entrance into the war has emphasized the following facts:

1. The essential solidarity of scientific research in all of its aspects and the ease with which investigators hitherto concerned only with pure science can deal with military and industrial problems.

2. The necessity of establishing and maintaining close cooperation between investigators formerly separated into academic, industrial, and military groups, and the immediate advantage to the nation which such cooperation has afforded.

3. The increased sense of obligation to the state on the part of all men of science and their strengthened desire to render their researches of the widest possible value.

4. The advantages certain to result in pure science from closer and more active cooperation between investigators who have specialized in its several fields, and from their contact with military and industrial problems.

5. The urgent necessity of strengthening the nation and compensating in part for the losses of war by the development of the industries through research.

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6. The recognition by far-sighted industrial leaders of their obligations to pure science, and their desire to assist in providing adequately for its future support and development.

7. The importance of taking immediate advantage of the present opportunity to promote the interests of science and research.

The proposed scheme of international organization is suggested as a means of utilizing the above facts to the advantage of science and technology, and for the mutual welfare of the nations of the entente. It is based on plans for the national organization of research, which must be presented first.

3. Establishment of national research organizations.—The national organization in each contracting State should be headed by the corresponding national academy of sciences, because of its close connection with the Government, its inclusion of the entire realm of the mathematical, physical, and biological sciences, and its previous international activities in the interest of science as a whole.

In view of the limited membership or scope of the several national academies, and the importance of including in the organization the most active leaders of research of each country, whether academy members or not, the following procedure is recommended: Let each national academy establish a research council, resting upon the charter of the academy and thus sharing in its national prestige and its relationship to the Government. These councils should be organized with the cooperation of the leading national societies interested in the promotion of research in the mathematical, physical, and biological sciences, and their applications in engineering, medicine, agriculture, and other useful arts. The membership of such research councils should comprise representatives of three principal groups: The heads and leading investigators of the scientific and technical services of the Government, both military and civil; active research workers in educational institutions and research foundations; and leaders of research in engineering, medicine, agriculture, and the industries. This membership should change from time to time in order to bring in fresh stimulus and ideas from all parts of the country, and to secure the advantages of cooperation with men of the widest range of interest. The council should have the active support of the best-known leaders of industry, whose indorsement of its purposes would weigh more heavily with the general public than that of men not identified with practical affairs.

Such an organization, in direct contact with the military and economic problems of the Government and the needs of science and research in educational institutions, in the industries, and in connection with many aspects of the public welfare, should be far more effective than any body more narrowly conceived. Necessities resulting from the war will force extensive efforts to overcome losses sustained in every field. So long as they are opposed by dangerous enemies, the nations of the Entente must develop their methods of defense by means of scientific research. We can no longer afford to depend solely upon foreign sources of supply, but must utilize research in order to meet our many needs for nitrates, dyestuffs, and other essential commodities. The burdens of heavy taxation must be lightened by reducing the cost of manufactured articles through research. The yield of our cultivated fields must be increased by the most scientific methods. The conditions of labor must be improved by every means that research affords. The supply of scientific investigators, sadly depleted by the war, must be made good by developing research in educational institutions. Pure science, fundamentally important to the State and not appealing directly to superficial thinkers, must be aided as never before.

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In support of all these activities, the common efforts of all who realize the importance of research, in science and in its applications, should be strongly united. Separate and unconnected movements to promote research in any field, carried out independently by men primarily concerned with pure science, industry, or medicine, lose many of the advantages which cooperation and mutual aid can supply. Thus the need in each country of a national research organization, federating all interests and preserving a just balance between the claims of science in its underlying branches and in its applications in the useful arts, would seem to be plainly indicated.

There need be no conflict between the type of organization here proposed and such bodies as the advisory councils for scientific and industrial research, recently established as government departments in England and several of the British colonies. Indeed, a working union between the British Advisory Council and the Royal Society, with the inclusion of representatives from the Admiralty, the Ministry of Munitions, the leading scientific and technical societies, and the industries, could accomplish the purposes in view. The Advisory Council would continue to exercise its present functions, while the proposed organization, federating research interests in all fields, including munitions, medicine, agriculture, fisheries, and forestry, which do not appear to lie within the scope of the advisory council, would provide the means of securing the widest cooperation and the means of utilizing in any field the principles and methods which have been developed elsewhere.

4. Establishment of an international research organization.—An international federation of such national organizations should provide the best means of meeting the general needs of science and research, and of securing the close and effective cooperation between the nations of the Entente that is essential to their future welfare.

This international body should comprise representatives of the several national research organizations and ultimately of special international associations dealing with research in engineering, medicine, agriculture, and the various branches of science and technology. A general meeting should be held annually, but a group of representatives should be constantly at work in a permanent office in London or Paris, where frequent conferences on international cooperation in research for military, industrial, or general scientific purposes would be held. Each contracting country should be officially represented at this office by members of the various technical bureaus and boards, military and civil, which are also represented in its national research organization. Means would thus be provided for a constant interchange of ideas, and close contact would be secured with research in all of its phases. Without such close cooperation we can not expect in the existing emergency to match our opponents in the development of military devices or in overcoming industrial difficulties created by the war.

At present, as indicated in the accompanying "Outline of plan for an inter-allied research council," we propose the establishment of a body especially adapted for war purposes. After the war, if it should then seem advisable, the scope of this organization may be expanded to any desired degree, even to the inclusion of history, philology, and related subjects.[1]

[1] This memorandum was prepared in the spring of 1918 and forwarded to the academies of the Entente soon afterward. At the time of the London conference it was evident that the end of the war was close at hand. The delegates of the National Academy therefore proposed that the national research councils, as well as the international body to be formed by their federation, be organized for service under peace conditions.

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After discussion by the conference, this recommendation for the establishment in each of the participating countries of a national research council, and the federation of these bodies to form an international research council, was unanimously adopted.

RESOLUTIONS ADOPTED.

The following resolutions were adopted by the conference:

1. That it is desirable that the nations at war with the central powers withdraw from the existing conventions relating to international scientific associations in accordance with the statutes or regulations of such conventions, respectively, as soon as circumstances permit; and that new associations deemed to be useful to the progress of science and its applications be established without delay by the nations at war with the central powers, with the eventual cooperation of neutral nations.

2. That certain associations, such as the metric convention, depending on diplomatic agreements, be taken into consideration during the peace negotiations.

3. It is not intended that these measures be applied to agreements relating to indispensable administrative relations between public services, such as those regulating navigation, meteorological telegrams, railways, telegraphs, etc.

4. A committee of inquiry be constituted by the conference, the academies of the countries at war with the central powers having power to add further members. This committee shall prepare a general scheme of international organizations to meet the requirements of the various branches of scientific and industrial research, including those relating to national defense. (The committee, with Prof. Schuster as acting president, will meet in Paris during the second fortnight in November.)

5. Each of the academies represented at the conference shall be invited to initiate the formation of a national council for the promotion of the researches specified in resolution 4.

6. An international council, having as nucleus the committee specified in resolution 4, shall be formed by the federation of the national councils.

7. The conference being of opinion that all industrial, agricultural, and medical progress depends on pure science, draws attention of the various governments to the importance of theoretical and disinterested researches, which after the restoration of peace should be supported by large endowments. The conference urges similarly the creation of large laboratories for experimental science, both private and national.

Resolved further:

8. That the resolutions of the conference, 1 to 7, be communicated by the academies to their respective Governments.

9. That the academies be requested to inform other learned societies in their respective countries of the resolutions adopted by the conference.

10. That the Royal Society be requested to inform, so far as possible, the bureaus of the international associations of the resolutions adopted by the conference with the request that they should take action in conformity with them.

PROPOSALS.

The following proposals were submitted by Prof. J. Massart:

1. To extend the system of international exchanges:

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(*a*) To effect a gratuitous interchange of publications having no commercial object (books, separate copies of papers, periodicals, etc.) between authors, societies, universities, museums, libraries, etc.

(*b*) To allow all scientific establishments in the allied countries to borrow books from all public libraries and to provide for gratuitous postal transmission.

2. To unify the courses of study at the universities so as to render possible—

(*a*) The exchange of students, who might then pursue their studies partly in one and partly in another country.

(*b*) The exchange of professors, perhaps including the exchange of scientific men who do not belong to the teaching profession, such as astronomical observers, librarians, curators of museums, etc.

3. To organize the publication of bibliographical works in all branches of science so as to render the allied countries independent of such works as Centralblatt, Jahresbericht. The Government should support such enterprises by subscribing to them.

M. Bigourdan submitted the following proposal:

That it is desirable to establish a uniform bibliographical notation relating to the whole extent of our knowledge in pure and applied science, philosophy, literature, etc.

And it was

Resolved, That M. Bigourdan's proposals be referred to the committee constituted under resolution 4, recommending them to their careful consideration.

And it was further

Resolved, That the proposals formulated by Prof. Massart, with the suggestions of Messrs. Volterra and Hardy, be referred to the committee contemplated under resolution 4, recommending them to their careful consideration.

The question of expulsion of enemy foreign members from scientific societies was also discussed, but as the sense of the meeting seemed to be that the declaration introducing the resolutions passed by the conference defined sufficiently the attitude of the allied academies toward the men of science of the central powers, no further action was taken.

PARIS CONFERENCE.

In accordance with the decision of the London conference, a second interallied conference was held in Paris under the auspices of the Paris Academy of Sciences from November 26 to November 29, 1918. This conference was attended by the following delegates:

Belgium.—Ch. de la Vallée Poussin, Georges Lecointe, J. Massart.

Brazil.—C. D. de Carvalho.

United States.—H. A. Bumstead, J. J. Carty, W. F. Durand, S. Flexner, G. E. Hale, A. A. Noyes.

France.—B. Baillaud, G. Bigourdan, Charles Flahault, Leon Guignard, Albin Haller, A. Lacroix, Charles Lallemand, Gabriel Lippmann, Charles Moureu, Paul Painlevé, Emile Picard, Edmond Perrier, Emile Roux.

Great Britain.—Sir F. W. Dyson, P. F. Frankland, J. H. Jeans, C. G. Knott, H. G. Lyons, E. A. Schafer, Arthur Schuster, S. Sherrington, E. H. Starling.

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Italy.—Gaudenzio Fantoli, Raffaello Nasini, Vincenzo Reina, Annibale Riccò, Vito Volterra.

Japan.—Jōji Sakurai, Aikichi Tanakadate.

Poland.—Ladislas Micklewicz.

Portugal.—Bettencourt Rodriguez.

Roumania.—Dragomir Hurmuzesco, G. Marinesco, L. Mrazec, Al. A. Soutzo.

Serbia.—Michel Petrović, J. Žujović.

RESOLUTIONS.

The International Research Council, proposed in the resolutions adopted in London, was provisionally constituted of the delegates attending the Paris conference, with the understanding that the various national research councils would take their place in the federation as soon as they are formed. An executive committee of five members, consisting of Messrs. Picard (chairman), representing France; Schuster (secretary), representing Great Britain; Lecointe, representing Belgium; Volterra, representing Italy; and Hale, representing the United States, was appointed to study in detail the questions presented to the conference and to undertake various other duties indicated in the resolutions given below:

RESOLUTIONS.

1. That the committee of inquiry referred to in article 4 of the conference of London shall temporarily assume the functions of the federation of national councils contemplated in the resolutions passed at London, and shall adopt the title of "International Research Council."

2. That each academy or Government represented on the committee of inquiry may at any time add to their delegates representatives of a national research council of the type contemplated in resolution 5 (London) or other similar body.

3. That the International Research Council at once appoint an executive committee of five members, which shall deal with all matters referred to it by the International Research Council.

4. That the executive committee shall take into consideration scientific or industrial projects of an international nature coming under the scope of resolution 4 (London), and more especially those concerning the formation of new associations, which shall be submitted to it by any academy represented at the conference or by any group of delegates either of the academies or of the National Research Councils. For this purpose the committee shall consult those bodies or persons whom it considers most suitable.

5. That the executive committee shall appoint separate special committees to consider in detail the formation of the new associations resolved upon in resolution 1 (London) in addition to those decided upon at the present meeting.

The members of these special committees need not be members of the International Research Council. Any special committee may appoint additional members by a vote in which not less than two-thirds of the total committee are favorable.

6. The executive committee shall have power to summon meetings of the International Research Council.

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7. The executive committee shall summon a meeting of the International Research Council as soon as, in their opinion, the body is in a position to assume its final form as contemplated in resolution 6 (London). The members of the executive committee shall then retire from their offices.

8. In the case of organizations which do not come within the scope of any of the committees appointed at this meeting, as well as in cases in which new organizations seem desirable, the executive committee may consult those bodies or persons whom it considers most suitable.

9. There shall be established under the direction of the executive committee an administrative bureau, which shall be responsible for the correspondence, the custody of documents, and administration.

DECLARATION OF POLICY.

The International Research Council recognizes that all great advances in science are initiated by individual efforts, and that it has become increasingly necessary to encourage these efforts. It includes therefore within its functions the task of actively encouraging all endeavors to supply the means and freedom necessary to those capable of conducting scientific researches of a high order.

Resolutions were also adopted relating to the bodies constituting the International Research Council and providing for the formation of committees to study (1) international services for the exchange of scientific publications and the loan of books and manuscripts; (2) the international use of existing laboratories and the establishment of additional ones; and (3) the preparation of a comparative examination of the university programs of the allied countries. The conference also took steps to initiate the formation of an International Astronomical Union, to deal with all such questions as have hitherto been included in the work of the Committee on the International Charter of the Heavens, the International Union for Cooperation in Solar Research, and other similar bodies; and an International Geophysical Union, dealing with geodesy, meteorology, terrestrial magnetism and atmospheric electricity, and seismology and vulcanology.

A plan for an International Chemical Council was also prepared and presented to the executive committee for consideration and action.

REPORT OF THE PATENT COMMITTEE.

In 1917 the Commissioner of Patents, with the approval of the Secretary of the Interior, requested the National Research Council to appoint a committee to investigate the Patent Office and patent system, with a view to increasing their effectiveness, and to consider what might be done to make the Patent Office a more truly national institution and more vitally useful to the industrial life of the country. This request was made by Mr. Thomas Ewing, at that time Commissioner of Patents, and subsequently a member of our Patent Committee.

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The National Research Council, in compliance with this request, appointed a Patent Committee, consisting of Dr. W. F. Durand, chairman; Drs. Leo H. Baekeland and M. I. Pupin, scientists and inventors; Drs. R. A. Millikan and S. W. Stratton, physicists; Dr. Reid Hunt, investigator in medical science; and Messrs. Frederick P. Fish, Thomas Ewing, and Edwin J. Prindle, patent lawyers. On the departure of Dr. Durand for Europe, Dr. Baekeland was appointed acting chairman of the committee.

The Patent Committee, believing the American patent system to be one of the most potent factors in the development of the prosperity of the country, and serving as a high incentive to invention and as an instigator of much of the activity which has led to the development of new methods and devices of great service in the war, has appreciated the importance of investigating the Patent Office and the patent system with special care, in the hope of increasing their effectiveness in harmony with the possibilties afforded by modern development in other fields.

As the result of an extended investigation the committee has proposed a program limited to but four features, because it believes these features to be of such fundamental importance that their enactment into law would strengthen the entire system, and directly or indirectly establish it upon a new and much more advantageous footing before Congress and the public; and because a simple program would be more likely to secure greater degree of unanimity of opinion in its support than would be possible if the program were more extended. The four proposals of the committee are as follows:

(1) The establishment of a single court of patent appeals that will have jurisdiction of appeals in patent cases from all the United States district courts throughout the country in place of the nine independent circuit courts of appeals in which appellate jurisdiction is now vested; (2) that the Patent Office be made a separate institution, independent of the Department of the Interior or of any other department; (3) a substantial increase in the force and salaries of the Patent Office; and (4) that section 4921 of the Revised Statutes of the United States be so amended as to enable the patentee in all suits where the patent has been found valid and infringed to recover at least a reasonable royalty, and to provide for a money recovery in the great majority of patent suits where no recovery would otherwise be possible.

The report of the committee, which deserves the most careful consideration by Congress, presents strong arguments in support of its proposals, and is accompanied by bills intended to carry them into effect. It will be published separately as a bulletin of the National Research Council.

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PROMOTION OF INDUSTRIAL RESEARCH.

One of the most striking consequences of the war is the increasing general realization of the primary importance of scientific research to the whole question of national defense, as well as to the successful prosecution of industry and the greatest measure of economy of resources after the war. The necessity of research work as the only means of solving many military and industrial problems raised by the war was realized by the British, who, despite the stress of war, have adopted a comprehensive scheme, under the supervision of a special committee of the Privy Council, to which Parliament has voted a sum of one million sterling. This fact in itself shows the importance which the British attach to the organization and prosecution of industrial research; and action in the same general direction has already been taken by France, Australia, Canada, and New Zealand, not to mention Germany, which has long been awake to this need.

Impressed by the great importance of promoting the application of science to industry in this country, the National Research Council took up the question of the organization of industrial research in the belief that this matter should be furthered in every way possible and as rapidly as may be, for the following reasons: In the first place, because of the necessity for rapid technical advance in many industries, if we are to compete successfully with other nations; secondly, because any steps taken in this direction will react immediately to further the general appreciation of science and of its usefulness when applied; thirdly, because the present time is conducive to the growth of new ideas—indeed, such a favorable opportunity may not recur. The matter has been very well put by Mr. Elihu Root, who, at a meeting called to discuss this general question made remarks, in part, as follows:

I have no justification for expressing views about scientific and industrial research except the sympathetic interest of an observer for many years at rather close range. One looking on comes to realize two things: One is the conquest of practical life by science; there seems to be no department of human activity in which the rule-of-thumb man has not come to realize that science, which he formerly despised, is useful beyond the scope of his own individual experience. The other is that science, like charity, should begin at home, and has done so very imperfectly. Science has been arranging, classifying, methodizing, simplifying everything except itself. It has made possible the tremendous modern development of the power of organization which has so multiplied the effective power of human effort as to make the differences from the past seem to be of kind rather than of degree. It has organized itself very imperfectly. Scientific men are only recently realizing that the principles which apply to success on a large scale in transportation and manufacture and general staff work apply to them; that the difference between a mob and an army does not depend upon occupation or purpose but upon human nature; that the effective power of a great number of scientific men may be increased by organization just as the

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effective power of a great number of laborers may be increased by military discipline. * * *

Under the international competitions of peace * * * the same power of science which has so amazingly increased the productive capacity of mankind during the past century will be applied again, and the prizes of industrial and commercial leadership will fall to the nation which organizes its scientific forces most effectively.

The National Research Council considers that cooperation between capital, labor, science, and management constitutes the best general means of financing and directing the extended laboratory investigations and the large-scale experimental and developmental work required for adequate industrial research. Accordingly it inaugurated an Industrial Research Section to consider the best methods of achieving such organization of research within an industry or group of related industries—e. g., industries using the same raw materials or with similar waste products. A report of the work of this Section may be found on page 64.

FINANCIAL SUPPORT.

As stated in the last Annual Report of the Research Council, its financial support at the outset was derived from a few personal contributions and from the action of the Engineering Foundation, which placed its secretary at the services of the Council and devoted its income to the Council's work. The action of the Chief Signal Officer in requesting the Council to organize the Science and Research Division of the Signal Corps, and in providing appropriations for the support of its work, afforded the means of conducting much research primarily useful to the Signal Corps and Aircraft Production Board, but also of great value to other branches of the service. Large funds for the general purposes of the council were not forthcoming, however, until the Carnegie Corporation made on June 6, 1917, an initial appropriation of $50,000, which was followed by an additional appropriation of $100,000 from the same source on May 20, 1918. The Rockefeller Foundation also recognized the possibilities of the Council's work in organizing research, and on February 27, 1918, appropriated $50,000 for the work of the Division of Medicine and Related Sciences. The Council is also indebted to Dr. W. W. Keen for a gift to the Division of Medicine and Related Sciences of $483.57, the royalties of his book entitled "The Treatment of War Wounds." Special grants from both the War and Navy Departments were made to cover the expenses of various investigations organized by the Council, and on January 7, 1918, the President authorized a grant of $29,250 from his special fund, through the Council of National Defense. The second important appropriation from the President's fund was the sum of $38,400, to provide for the initial work of the Research Infor-

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mation Committee. Subsequent grants were also made by the President to provide for the organization of our office in Rome and for other expenses of the Council. The last grant from this source was authorized on September 11, 1918, and provided $61,000 for the expenses of the Research Information Service and general expenses of the council during the first six months of 1919.

Of these appropriations to the Council, those which were available for use during the fiscal year ending June 30, 1919, are as follows:

Carnegie Corporation	$100,000.00
W. W. Keen	483.57
Rockefeller Foundation	[1] 50,000.00
President's fund	122,000.00
	272,483.57

The disbursement of these funds is shown in the treasurer's report, which is appended.

The conclusion of the war, and the necessity of providing ample funds for the continuation of the Council's work under peace conditions have led to a careful consideration of the best means of securing financial support in the future. The Rockefeller Foundation has made an additional appropriation of $15,000 for the work of the Division of Medicine and Related Sciences, and the Bell Telephone System, at the request of Mr. Theodore Vail, has guaranteed $25,000 per year toward the expenses of the Council on condition that $250,000 per year for five years be secured. It is hoped that the efforts which are now being made to obtain funds from private sources, and also to secure further appropriations from the Government for the Research Information Service and for other activities of the Council, will soon meet with success.

PERMANENT ORGANIZATION.

Much time has been devoted during the year, especially since the signing of the armistice, to the preparation of a permanent scheme of organization for the Council. During the absence of the chairman in Europe, the acting chairman, Dr. John C. Merriam, requested each of the divisions of the Research Council to give special consideration to this problem. The results of their studies have been utilized by a special committee in preparing a plan of organization which has been further developed by the executive board of the Research Council and the Council of the National Academy.

The scheme of organization in divisions, which group together representatives of related branches of science and technology, has proved so satisfactory during the period of the war that it will be continued, with such minor modifications as appear desirable. The

[1] The unexpended portion of this grant reverted to the Rockefeller Foundation on Dec. 31, 1918.

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principle of rendering the Council an effective federation of the leading research agencies of the country will be perfected through the provision that the majority of the members of each division shall consist of representatives of leading national scientific and technical societies. Thus the Engineering Division, already partially constituted under the new plan of organization, includes representatives of the American Society of Civil Engineers, the American Institute of Mining Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, the Western Society of Engineers, the American Society for Testing Materials, the Society of Automotive Engineers, and the Illuminating Engineering Society, to which representatives of other societies and research organizations will be added in the future. The Divisions of Physical Science, of Chemistry and Chemical Technology, of Geology and Geography, of the Medical Sciences, of Biology and Agriculture, and of Anthropology and Psychology will be similarly constituted of the representatives of the leading national societies in these subjects, together with certain members at large, so chosen as to render the membership of each division best adapted to secure effective cooperation in its field. Representatives of the Government will be appointed by the President of the United States, as heretofore, and the heads of the scientific and technical bureaus of the Army and Navy and of the civil departments, grouped together in the Government Division of the Council, will be in a position to arrange for cooperation between these bureaus. Such representatives, together with those drawn from universities and research foundations and from industrial laboratories, will constitute a thoroughly comprehensive organization of the research interests of the country.

But the Research Council is something very different from a scientific society, holding occasional meetings for the reading of papers. Each of its divisions meets frequently, and during the intervals between these meetings the work of the division is conducted by a chairman, resident in Washington during his term of office, together with a vice chairman and a small executive committee. In addition there are the permanent officers of the council, who devote their whole time to its work and maintain its continuity. More complete details may be found in the appended plan of organization as finally adopted by the Executive Board of the Council and by the Council of the National Academy of Sciences (p. 109).

REPORTS OF DIVISIONS.

DIVISION OF GENERAL RELATIONS.

ARTHUR A. NOYES, *Chairman.*

Foreign Relations.—The Foreign Relations Section has hitherto consisted of the chairman of the Council and a few members who have

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given special attention to international questions. Its chief work has been the study of plans for international organization which have taken definite form in the establishment of the International Research Council and in the initiation of some of the special international bodies which are to be associated with it. The section will soon be established as the Division of Foreign Relations under the new scheme of organization, and will then include representatives of the leading international scientific and technical associations in which the United States takes part.

Industrial Relations.—In pursuance of the general plan mentioned on a previous page, the Research Council formed an advisory committee composed of men able to foresee the general benefits which would certainly follow from the further progress of science and from a more general and more thorough application of science to industry. The present membership of the advisory committee is as follows: Theodore N. Vail (chairman), Cleveland H. Dodge, George Eastman, E. H. Gary, A. W. Mellon, Pierre S. Du Pont, H. S. Pritchett, Edwin Wilbur Rice, Jr., Elihu Root, Ambrose Swasey.

The active work of the Section was undertaken in cooperation with the Engineering Foundation; and at a meeting held in New York on May 29, 1918, at which most of the members of the advisory committee were present, the following group was chosen to conduct this work: John Johnston (chairman); L. H. Baekeland, Naval Consulting Board; G. K. Burgess, Bureau of Standards; F. G. Cottrell, Bureau of Mines; A. D. Flinn, secretary of Engineering Foundation; C. E. K. Mees, Research Laboratory, Eastman Kodak Company; Walter Rautenstrauch, Columbia University; W. R. Whitney, Research Laboratory, General Electric Company.

It was considered that the first work to be undertaken should be propaganda, and it was planned to issue a series of bulletins written by men competent to deal with various aspects of the general subject. The demands of the war upon the time of these men, however, have delayed this plan, but it will be put into operation in the near future.

As an illustration of the fact that the industries in this country are awakening to the importance of industrial research, it may be mentioned that the National Association of Cotton Manufacturers at their annual meeting in May devoted an afternoon to consideration of "Research as an aid to industrial efficiency"; the addresses made at this meeting have been republished. (Transactions of the National Association of Cotton Manufacturers, 103–104, 545–592, 1918.) At the instance of the Industrial Relations Section of the Research Council a topical discussion on cooperation in industrial research was held at the meeting of the American Society for Testing Materials, which took place in Atlantic City on June 26, 1918. This session was largely attended, and those present evinced considerable interest in

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the matter. A full report of this discussion has been printed in the Proceedings of the Society (Vol. XVIII, Part II, pp. 1–63, 1918).

It was thought desirable to draft some concrete schemes for cooperative research, similar to those which have been formulated by the British Advisory Council for Scientific and Industrial Research, and an opportunity to do this was afforded by the newly organized American Zinc Institute, which requested the chairman of the Section to speak at its meeting in St. Louis on July 31, 1918, on the "Value of cooperative research work in the development of the zinc industry." The interest shown in this paper, which has been published in the Proceedings of the American Zinc Institute, 1918 (pp. 49–55), led the chairman to draft a provisional prospectus of a zinc research association. This prospectus was sent to the members of the Section, and with their approval was submitted to the American Zinc Institute, who are, we understand, giving this question very careful consideration.

One of the important industries upon which a large number of other industries depend is the refractories industry. This is more of a key industry than might at first sight appear to be the case. For instance, successful metallurgical practice depends upon satisfactory refractory furnace linings, and the need of chemical porcelain and glass is too well known to require further emphasis here. This industry has been in a relatively backward state in this country, and as most of the manufacturers engaged in it work upon a relatively small scale, it seemed to offer an exceptional opportunity for the establishment of a research association. Accordingly a scheme was drafted by Dr. E. W. Washburn, chairman of the Committee on Ceramic Chemistry, of the Council. This scheme is being presented to those interested in refractories and will be published in the near future. In this case, however, it is questionable if it will be feasible in the immediate future to get the manufacturers together; but it may be possible to arrange for research carried out by an organization supported by the users of refractories who, perhaps, are even more interested in the improvement of refractories than are the present manufacturers. Indeed, at a recent meeting of the Section it was considered that in many cases this might be the better way to proceed, and active steps toward the formation of an organization for alloy research on this basis are being taken.

Section on Relations with Educational Institutions and State Committees.—The sections on state council relations (through state research committees) and on research in educational institutions have been combined into one Section on Relations with Educational Institutions and State Committees, with Dr. J. C. Merriam as chairman, on account of the close relation of the problems with which the former two sections had to deal.

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The following states have formed committees on scientific research of their state councils, cooperating with the National Research Council: Arizona, California, Illinois, Indiana, Minnesota, New Hampshire, Oklahoma, Oregon, Tennessee, Utah, and Washington. University research committees have been formed in 88 institutions of learning. In some states these committees have been extremely active on emergency problems which have been carried forward through many special subcommittees. Throughout the war it has been the policy of the Research Council to encourage state scientific committees, scientific institutions, and scientific men to undertake at their own initiative such investigations as might bear on the successful prosecution of the war, and to invite their cooperation in the solution of emergency problems forwarded to them. In some cases special appropriations were made by the states to assist research committees and many institutions applied their research facilities to war work. Investigations thus undertaken frequently became so promising in their initial stages that they were taken over completely by federal or state authorities for continuation at government expense. The census of research men conducted in the states and institutions led to the recognition of investigators needed in government service, both civil and military. Many men have thus entered the national service through the activities of the state and university research committees in cooperation with the National Research Council. The service rendered the federal government in promoting the war has fully justified the establishment of state and university research committees. The results of this undertaking have been larger than could have been anticipated. At the same time a stimulus for scientific research has been created throughout the nation which will be of the highest importance in times of peace.

Reports of individual, state, and university research committees are being published by the state councils of defense and by the institutions.

At the request of the War Department's committee on education and special training the section has reviewed the qualifications of research men within draft limits for selection for governmental research work. The Research Council has accepted membership in the American Emergency Council on Education and has kept in close touch with this organization, which has done important work in bringing together the educational interests of the country, originally for war purposes, and since the armistice in connection with reconstruction problems. The Section has assembled a large amount of research information from the states and institutions, which has been distributed through the Research Information Service. It has also undertaken the compilation of research funds and fellowships available in the United States for research.

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The university research committees will naturally continue without much change in organization or policy after the close of the war. At the request of the committee, the Bureau of Education has undertaken to bring together organized information concerning the present status of research work, of the training of investigators, and of research staffs in educational and research institutions. One of the purposes is to determine whether the supply of men being trained for future work in various fields of research seems sufficiently large to meet the needs of the country. Another aim is to study the possibilities of fundamental university work after the war.

Special Committee on Education and Special Training (J. C. Merriam, chairman).—At the request of the Committee on Education and Special Training of the War Department, this Committee has undertaken, in cooperation with the Divisions of Science and Technology, the preparation of courses of instruction in the sciences contributing to the training of men preparing for military service and later more particularly of men enlisted in the Students' Army Training Corps at educational institutions. These courses of study have been forwarded by the War Department to the institutions in mimeographed form and have been of service in reorganizing curricula for the mobilization of their resources to meet the educational emergency needs of the Army and Navy. In some cases the science curricula have been expanded to syllabi and textbooks.

The committee has served as the connecting link between the Divisions of Science and Technology of the Council and the War Department's Committee on Education and Special Training in placing educational institutions on a war basis. It has cooperated with the War Department's committee, the Bureau of Education, and various other organizations in many other respects.

Committee on Reconstruction Problems (Vernon Kellogg, chairman; F. H. Newell, vice chairman).—The National Research Council, anticipating the end of the war, appointed a special committee on reconstruction problems, which completed its organization August 18, 1918, and adopted a program calling for a study of the agencies and activities that have to do with after-war problems.

The situation was discussed by conference, correspondence, and consultation of publications, and it was found that many organizations throughout the United States—federal, state, municipal, and private—have taken up or are about to take up one or another phase of these far-reaching matters. With the signing of the armistice in November, the reconstruction problems at home and abroad have come into the foreground, and plans were considered by the Council of National Defense and the state councils interested.

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After completing this general survey, the committee on reconstruction problems decided to limit its efforts to certain specific undertakings, which, as shown by the inquiry, have not been covered by other organizations. One of the most important and far-reaching of these is the research into details which relate to the control of water in its relation to food production and other industries.

At the present time there does not appear to be any one body or organization which is conducting a research into the mathematical, physical, and biological data bearing upon irrigation, drainage, flood control, and the application of these to engineering and agricultural science. It is recognized that many important undertakings are in the hands of several bureaus of the Government, each dealing with one phase or another of these subjects, and that a large amount of information has been collected and, by proper coordination, may be made available for research of the kind proposed.

The committee contemplates a report having to do with reconstruction, both at home and abroad, somewhat along the lines of a publication issued by the Division of Geology and Geography of the Council, entitled "Military Geology and Topography." The report, it is expected, will cover subjects of quantity, quality, and availability of water and its use in agriculture, power-production, and similar enterprises.

Under recent conditions the grouping, rounding out, and publication of data on water resources have peculiar value, since questions of water supply and control enter so largely into all reconstruction plans throughout the world.

In addition to the specific researches and preparation of the report referred to, the committee has also under consideration other lines of inquiry into reconstruction problems, which are in the course of development.

MILITARY DIVISION.

CHARLES D. WALCOTT, *Chairman;* S. W. STRATTON, *Vice Chairman.*

The Military Committee of the National Research Council, which was one of the first committees to be organized, was very effective in securing the necessary cooperation with the Army and Navy in the solution of research problems. Under the war organization this committee became the Military Division of the Council. The most valuable results of its work have been the organization of the Research Information Service and the authorization and organization of the weekly conferences on war problems of the Divisions of Physics and Engineering, in which representatives of the Army and Navy as well as the civil bureaus of the Government regularly participated (see report of Physics Division).

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DIVISION OF PHYSICS, MATHEMATICS, ASTRONOMY, AND GEOPHYSICS.

ROBERT A. MILLIKAN, *Chairman;* CHARLES E. MENDENHALL, *Vice Chairman.*

The membership of the executive committee of this division, fully set forth in the war organization appended to this report, includes representatives of physics, astronomy, mathematics, and geophysics. Effective cooperation between the various services of the Government was also provided for through the fact that these members were connected, respectively, with the Signal Corps, the Bureau of Aircraft Production, the Bureau of Ordnance of the Navy, the Bureau of Ordnance of the Army, the Chemical Warfare Service, the Weather Bureau, the Advisory Committee for Aeronautics, the Bureau of Standards, and the Carnegie Institution of Washington. The meetings of the executive committee were devoted to the discussion of war problems, and also to the preparation of plans for the permanent organization of the Division of Physical Sciences, the formulation of policies regarding the Research Information Service, the organization of research in the Army, and the establishment of the weekly conference of the Physics and Engineering Divisions. This conference was of such importance in connection with the war that a detailed statement regarding it should be included here.

In the spring of 1918 the Military Committee of the National Research Council, upon the initiative of the Division of Physics, authorized the establishment of a weekly conference of the Physics and Engineering Divisions for the discussion of the new scientific and technical problems facing both the Army and the Navy. These conferences were held each Thursday evening throughout the remainder of the year at the office of the Research Council, and were attended on the average by about 50 Army and Navy officers and civilian scientists engaged in war research. They proved of the greatest utility in furthering progress through the interchange of ideas between the different research groups both here and abroad. At each meeting all of the reports received through the Research Information Service from the foreign research groups since the last meeting were briefly summarized and discussed and detailed discussion devoted to such reports as warranted it. Further, these meetings became a recognized place of report of officers of our own service returning from Europe on scientific and technical missions and also of officers of foreign governments connected with the various foreign war missions. To preserve the necessary secrecy the meetings were held under the authority of the Army and Navy Intelligence Services, and the group authorized to attend consisted of the official representatives of the various war missions, officers specially delegated each week by the chiefs of the bureaus of the Army and Navy, and some

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30 civilian scientists, all of whom were passed upon by both the Army and Navy Intelligence Services. These meetings constituted one of the most effective war services rendered by the National Research Council, and had a marked effect in accelerating research and development projects and in pointing out useful new lines of endeavor.

As the major part of the reports sent to this country through the scientific attachés in London, Paris, and Rome have dealt with subjects coming directly within the field of the Physics Division, Dr. F. C. Blake was later appointed by the executive committee of the Division to study thoroughly all appropriate material coming in from abroad, and to arrange for its full presentation before the weekly conference of the Physics and Engineering Divisions and its distribution to the proper research groups in this country. He also assisted the Research Information Service in obtaining reports for transmission abroad upon physical problems under investigation in the United States.

It is clear from its membership and plan of organization that the Physics Division, like the Research Council itself, is a federation of research groups both inside and outside the War and Navy Departments and the civil branches of the Government. Many of the researches initiated under its auspices, as, for example, that on the submarine problem, were undertaken before most of its members were connected with the Army and Navy Departments. As the war progressed the membership of the Division became more and more completely incorporated into the Army and Navy, and large funds from both of these sources became available for the continuation of the work. Thus, the chairman and vice chairman of the Division were placed, in the autumn of 1917, in charge of the Science and Research Division of the Signal Corps, which was organized by the Research Council at the request of the Chief Signal Officer. The original problem organization of the Physics Division has been maintained, and the executive committee of the Division has continued to discuss and to make recommendations upon the various problems initiated by its members, whether these problems have in their later stages been financed by Research Council funds or by funds of those branches of the Army and Navy with which the members of the Division were subsequently connected.

The problems considered by the Division may be grouped under nine heads, as follows:

A. Airplane instruments.
B. Bomb sight, bomb trajectory, and stabilization problems.
C. Photographic problems.
D. Signaling problems.
E. Detection problems.
F. General airplane problems.

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G. Balloon problems.
H. Ordnance problems.
I. Miscellaneous problems.

Most of these were carried out under the Science and Research Division of the Signal Corps and the Bureau of Aircraft Production.

It would be impossible within the limits of this report to discuss the details of the seventy-odd problems in which the Physics Division was directly or indirectly concerned. Moreover, in many cases it would be manifestly inappropriate to do so, partly because of the confidential character of the work and more particularly because certain investigations were carried out at the expense and under the immediate direction of a branch of the Army or Navy or some body other than the National Research Council.

The nature of the council as a federation of research activities, and the fact that its prime concern is in the accomplishment of an important result rather than in the precise mode of procedure by which that result is obtained, naturally made its functions in the study of war problems very diverse. In some instances its work was limited to the initiation of investigations, which were sooner or later taken over by some other agency of the Government well qualified, through the possession of available funds and the necessary means of research, to conduct them to successful conclusion. In other cases, where suitable Government agencies were not available, the Research Council not only organized extensive investigations but provided funds and even erected laboratories provided with special equipment for solving vitally important problems. In the Physics Division these and other modes of procedure were all abundantly illustrated, as a detailed history of the origin, primary organization, and development of each problem dealt with would render clearly apparent. In this brief mention of the report of the Physics Division we must content ourselves with some reference to certain problems of special significance, in which the Research Council, for one reason or another, was called upon to play a leading part.

Perhaps the most notable case in point is the submarine problem. The importance of devising means for the detection and destruction of submarines was clearly apparent long before the United States entered the war. The Bureau of Steam Engineering of the Navy Department was fully alive to the importance of the problem, and in conjunction with the bureau the General Electric Co., the Western Electric Co., and the Submarine Signal Co. attacked the question with vigor. The Naval Consulting Board also recognized fully the seriousness of the situation and organized investigations of a similar character. As for the National Research Council it was recognized from the outset that this question, like many other scientific investi-

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gations dealt with under peace conditions, called for international cooperation. Accordingly the council dispatched a scientific committee, under the chairmanship of Prof. Joseph S. Ames, to France and England at the very beginning of the war to gather information bearing upon military and naval problems, and to secure early and effective cooperation in dealing with them. The French Government cordially responded, and a strong group of scientific men, under the chairmanship of M. Fabry, familiar with all aspects of the research problems dealt with in France from the beginning of the war, was sent to the United States upon a return visit. The English and Italian men of science, with whom arrangements for cooperation had also been made, sent representatives, including Sir Ernest Rutherford and Commander Cyprian Bridge from England and Lieut. Giorgio Abetti from Italy, to join the French committee in the United States.

Soon after the arrival of these gentlemen in Washington the Research Council, acting in cooperation with the Navy Department, organized a conference on the entire submarine problem, in which representatives of the Navy Department, with physicists and engineers already engaged in the study of the problem, joined with the French and British representatives. The results of this conference indicated such large possibilities that a group of some 50 physicists and engineers were brought together by the Research Council for a second three-day conference. As a result of these conferences a large number of investigations, for the most part dealing with the problem of submarine detection, were organized by the Research Council in cooperation with the Special Board on Anti-Submarine Devices of the Navy, which had entire jurisdiction over all anti-submarine experimenting in this country. The board consisted of a number of naval officers representing various bureaus of the Navy, together with four civilian members, one of whom was the chairman of the Physics Division of the Research Council and chairman of its Anti-Submarine Committee. The greater part of the experimental work of the Special Board on Anti-Submarine Devices was done at the New London Experimental Station, at which members of the Committee on Submarine Investigations of the National Research Council began work in June, 1917. The work of the Station attained such success in its initial stages that the Navy Department provided ample funds for its maintenance and development, and its work was subsequently carried out on a large scale at New London and elsewhere. Besides appointing the nucleus of the scientific group organized at New London and providing for initial expenses of travel, etc., the Research Council established additional antisubmarine groups at New York, Madison, Wis., Chicago, and in connection with the submarine base at San Pedro, Calif. A

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special laboratory was also erected at the expense of the Research Council at Pasadena, Calif., where marked success has been attained in the development of a special detection device by members of the San Pedro group.

This illustration has been given in some detail because it indicates clearly one of the chief modes of procedure of the Research Council. The many other investigations and activities set on foot by the division will doubtless be reported in due time from appropriate channels. Some of these, while involving research as an important factor, were primarily questions of the organization of scientific methods for military purposes. Thus, in the case of sound-ranging methods for the location of enemy artillery, the Research Council, at the request of the Chief Signal Officer, initiated the work by the appointment of Dr. Trowbridge at the head of the service, and the association with him of Dr. Rosa, Dr. Williams, and others. Dr. Trowbridge was appointed a major in the Signal Corps, and subsequently, after the work had been transferred to the Engineer Corps, he had charge of the service with the Army in France as a Lieutenant Colonel of Engineers. In this country, important developments in the methods were effected at the Bureau of Standards, at Princeton, and elsewhere, most of this work being done under the auspices of the Engineer Corps, and with funds furnished by them. The case of meteorology was somewhat similar, the Research Council taking part only in the initiation of the work, which was afterwards conducted on a large scale under the Signal Corps of the Army.

Among other problems in which the division was particularly interested were many dealing with special optical questions for secret signaling purposes, for increasing visibility at sea, for detecting camouflage, and for a variety of other purposes. The methods used in submarine detection furnished the basis for important devices for the detection and location of airplanes by sound, and for other problems involving the application of similar principles. Prof. Michelson, of the University of Chicago, was early in 1917 assigned by the Research Council to the problem of the development of an improved coincidence range-finder. This work has been carried on as part of the activity of the Physics Division of the Research Council, and with funds supplied by the University of Chicago up to the middle of 1918, when the preliminary instrument was approved by the Bureau of Ordnance of the Navy, Prof. Michelson given a commission in the Navy, and the problem from that time forth transferred to the Bureau of Standards, where it was financed by the Bureau of Ordnance of the Navy.

The study of bomb sights, bomb trajectories, and stabilization problems received much attention from the Physics and Engineering Divisions. Some of the developments of this work were very important, as they led to a marked reduction in the errors of bombing.

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At the request of the War and Navy Departments, the Research Council appointed a special group, of which Dr. Harvey N. Davis was chairman, to study and report upon the possibilities of obtaining helium from natural gas, through methods proposed by Mr. Norton, by the Linde Air Products Co. and by the Air Reduction Co. Dr. Davis, who contributed in an important degree to the success attained by the Army, the Navy, and the Bureau of Mines in this work, was later made the representative of the Army in dealing with the problem. At the time of the signing of the armistice 147,000 cubic feet of helium were ready for shipment abroad.

Among other balloon problems studied by Research Council groups were those dealing with the elimination of explosions due to sparks (Drs. Swann and Fulcher) and the method of ignition of hydrogen balloons by incendiary bullets (Drs. Davis, Fulcher, Wells, and others).

Another activity of the Physics Division, working in cooperation with the Engineering Division of the Research Council, and with members of the Bureau of Aircraft Production, was the development of a special device of sounding balloons, referred to in the report of the Engineering Division. In cooperation with the Signal Corps and the Weather Bureau, an important application of these balloons to the study of upper-air currents was also recognized.

A Research Council group, consisting of Dr. Paul Klopsteg, of the University of Minnesota, and Dr. Rosa, of the Bureau of Standards, was formed in the summer of 1917 for developing new and improved methods of measuring initial speed of projectiles. This group successfully developed a new method which has been adopted to some extent, both in this country and abroad. It diminishes greatly the time required to make speed determinations. This work was financed principally by the Bureau of Ordnance of the Army.

At the initiative of the Physics Division and with funds furnished chiefly by the Signal Corps and partly by the Research Council, Dr. D. C. Miller, of Cleveland, spent a large part of the summer of the year 1918 in the development of special apparatus to be used in a complete study of the pressure wave about the muzzle of a large gun.

Prof. Raymond Dodge, of the Psychology Committee, was brought into contact, through the activities of the chairman and vice chairman of the Physics Division, with the need for a piece of physical apparatus for the selection and training of gun pointers. Prof. Dodge developed for the Navy a most satisfactory physical instrument, which has been adopted and used both here and abroad.

At the request of the General Staff, the Physics Division of the Research Council appointed a special committee, with Edward P. Hyde, of Cleveland, as chairman, for making a scientific study and report upon the relative merits of monoculars and binoculars. This

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committee made very elaborate investigations, both in the laboratory and with a group of 70 officers of the General Staff in the field.

A special committee of the Research Council, consisting of Dr. C. G. Abbot, chairman, and certain members of the Bureau of Standards and of the Engineer Corps of the Army, was appointed in the fall of 1917 for improving the searchlight. This committee has done a large amount of work which has resulted in useful developments, which have not, however, as yet come into practice.

The Research Council has had a committee, consisting of Drs. H. N. Russell and G. B. Pegram, which has cooperated with Maj. Boyle, of the Department of Ordnance, in the development of anti-aircraft fire-control devices.

These illustrations will suffice to indicate the character of the work of the Physics Division. Reference must be made to subsequent special reports for the details of the work.

ENGINEERING DIVISION.

HENRY M. HOWE, *Chairman;* G. H. CLEVENGER, *Vice Chairman.*

The Engineering Division was organized in March, 1918, and Dr. Henry M. Howe was appointed chairman in April, 1918. The Division as originally constituted consisted of—

1. Section on Metallurgy, under the chairmanship of Prof. Bradley Stoughton.
2. Section on Mechanical Engineering, under the chairmanship of Mr. W. J. Lester.
3. Section on Electrical Engineering, under the chairmanship of Prof. C. A. Adams.
4. Section on Prime Movers, under the chairmanship of Prof. Lionel S. Marks.

In order to be of the greatest assistance in winning the war, each section took up the problems of most immediate need, and attacked them in the manner which appeared to give promise of the most efficient and rapid solution. This accounts in a large measure for the radically different methods pursued in the different sections, and also accounts for what may appear to be a lack of balance between the sections.

SECTION ON METALLURGY.

The section on metallurgy has worked chiefly through the creation of committees which during the war period attacked specific problems of importance in connection with the war.

Pyrometer committee.—The committee was formed under the chairmanship of Dr. G. K. Burgess for the purpose of developing a pyrometer for measuring the temperature of steel baths in furnaces, especially in open-hearth and electric furnaces. A satisfactory instrument for this purpose would result in better control of the process

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of manufacture, and hence an improvement in the quality of the steel produced. Under the direction of Mr. F. E. Bash a considerable amount of experimental work was carried out at the plant of the Midvale Steel Co. The results of this work indicate probable lines along which successes can be attained.

Ingot committee.—This committee was formed for the purpose of determining the best practice in the making of steel ingots. It was under the chairmanship of Lieut. Col. W. P. Barba. At the time of the signing of the armistice the Ingot Committee was arranging to publish under the form of "Recommended practice" a complete set of detailed directions covering the practice of the best makers of fine steel suitable for guns, shells, etc., practice which until then had been kept strictly secret. This was to be done through the collaboration of the metallurgists of the Ordnance Department, ordnance engineers, and eminent metallurgists of the most important makers of ordnance steel in this country. The preparation of this "recommended practice" is still being carried on by Dr. Howe.

Fatigue phenomena committee.—A committee for the study of this important subject was formed, and Prof. F. H. Moore made chairman. As a result of the work of this committee advances were made in the existing knowledge of fatigue of metals, and the permanence of the elevation of the elastic limit caused by distortion in the cold. The results of this investigation, so far as it has proceeded, are recorded in a paper to be presented at the February meeting of the American Institute of Mining Engineers. Briefly, it tends to show that the elevation of the elastic limit caused by cold rolling, wire drawing, etc., is dissipated by indefinite repetition of a wide variation of stresses, as for instance in aircraft crank shafts.

Protective body armor committee.—Maj. Bashford Dean was chairman of this committee, one group of which was active for a considerable period in the study of old types of body armor and their adaptation to modern warfare. The other group of this committee, under Dr. Howe, devoted to the study of the best types of steel for helmets, has been particularly active. Some of the steels experimented with have shown greatly superior resistance to denting and perforation as compared with the regulation manganese steel helmets formerly used. This research is being continued by Mr. W. J. Wrighton, and when completed will offer a great deal of information upon the subject not previously known.

Manganese saving committee.—This committee, under the chairmanship of Mr. J. E. Johnson, jr., in cooperation with the United States Bureau of Mines, studied the practice of producing ferromanganese and its use in steel making. The results of this work pointed to the possibility of improvements in the practice of steel making which would effect a saving of manganese resources, thereby

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releasing the shipping which at the time was engaged in the importation of manganese ores. The results of these studies are embodied in two papers which will be presented at the February meeting of the American Institute of Mining Engineers.

Metallurgy subcommittee of welding committee.—This committee was formed for studying the metallurgical problems arising in connection with the work of the electric welding committee. It is a subcommittee of the welding research subcommittee, and its chairman is Mr. S. W. Miller. This committee has made important progress in ascertaining the causes of the brittleness of autogenous welds, more particularly electric welds. The more important conclusions which have been reached as a result of their work will be discussed in a paper which will be presented at the February meeting of the American Institute of Mining Engineers.

New committees.—In addition to the above committees a number of new committees were being formed at the time the armistice was signed. There are now a total of 16 committees in the Section of Metallurgy. The work of the older committees, as well as the newly-formed committees, is steadily going forward, as it is generally recognized that all the subjects covered by the work of these committees are of great importance in peace time.

SECTION ON MECHANICAL ENGINEERING.

The Section on Mechanical Engineering had presented to it an entirely different type of problems from those arising in connection with metallurgy. The work in this Section has consisted largely in the development of certain war inventions, most of which came to it in a nebulous state. In order to do this work effectively, it was necessary to have a staff of designing engineers and draftsmen, also a shop with a full complement of machinists, experimenters, etc., for constructing full size or working models of the various devices. Through the courtesy of the Carnegie Institute of Technology, a large section of their shops was rendered available for this work. Under the direction of Lieut. T. H. Sloan a considerable force of both enlisted men and civilians has carried on this work since July, certain of the devices being of such promise that work has been continued on them since the armistice was signed.

Telescope signaling.—The Section of Mechanical Engineering cooperated with the Physics Division and with Maj. Wood, of the Signal Corps, in the redesign of the original telescope signaling device. After this instrument was approved 100 of them were manufactured in the Pittsburgh shops and were ready for shipment abroad when the armistice was signed.

Dual control cut-out.—As the result of a conference of the Physics Division with Mr. W. J. Lester, chairman of the Section of Mechanical Engineering, he was requested to develop certain ideas which he had

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for a dual control for airplanes, in which the instructor could at any time mechanically disconnect the beginner's control. It was believed that a device which would render this possible would considerably reduce the number of accidents at airplane training fields. The device developed gave satisfactory results in a preliminary test.

Long-range propaganda balloons.—Through the energy and perseverance of Mr. W. J. Lester, with the later cooperation of the Science and Research Division of the Signal Corps, means of automatically maintaining small balloons at any predetermined altitude by alternately throwing out liquid ballast and releasing gas were worked out and thoroughly tested. Results of this work were highly satisfactory. Tests made by setting the control mechanism for an altitude at which it was known the prevailing easterly air currents would be encountered, using balloons but 9 inches in diameter (before inflation), resulted in several balloons traveling easterly from Fort Omaha for a distance of nearly 1,000 miles, and one traveled a distance of over 1,100 miles. This is a much greater distance than that ever previously covered by the flight of small balloons. They were at once sent by special messenger for use at the French front. It is now proposed to use these balloons for ascertaining the air currents above the Atlantic Ocean between the American and European coasts.

Armored motorcycle.—It was evident that casualities among our troops during open fighting could be greatly reduced if there was a means of carrying forward with them small armor-plate shields in sufficient numbers. It was essential that such a device should be capable of production in very large numbers and in a minimum length of time. To meet this need a design embodying a standard motorcycle was developed and one of the machines assembled at the plant of the Savage Arms Co.

Centrifugal gun.—The designing and construction of a centrifugal gun, which grew out of plans originally submitted by Mr. E. L. Rice, has been carried forward by this section, in cooperation with the Physics Division, at the Pittsburgh shops. Most of the previous designs for such a gun have had a common defect which has been difficult to eliminate. Considerable headway has been made in solving this problem, and it is thought possible that this type of gun may be eventually developed into an effective weapon.

Improved carburetor.—A new type of carburetor for use on airplanes was designed and constructed, but has not yet been tested.

Other work in which more or less progress was made was a rotary internal-combustion engine, parachute for airplanes, pneumatic anti-submarine gun, supertank, locking differential for motor trucks, walking-beam tractor for use in extremely soft ground, automatic

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constant speed airplane propeller, balloon flare, compressed-air drive for centrifugal gun, hovering airplane designed to remain stationary in the air, and a double-propeller engine.

SECTION ON ELECTRICAL ENGINEERING.

The work of this Section was confined to the intensive study of electric welding, more particularly, as applied to shipbuilding. A large and very active committee, under the chairmanship of Prof. C. A. Adams, worked upon this problem in cooperation with the Emergency Fleet Corporation of the United States Shipping Board. Working with the welding committee was a subresearch committee under the chairmanship of Mr. H. M. Hobart, and working with the subresearch committee was a submetallurgical committee under the chairmanship of Mr. S. W. Miller.

As a result of the well-organized work of this large group, noteworthy advances were made in the practice and use of electric welding as applied to shipbuilding. A steel barge was fabricated, employing electric welding throughout, no rivets whatever being used. This barge was successfully completed and placed in commission. This achievement may be considered an important step in the evolution of a completely electrically welded ship. Several new and important laws were established in connection with the art of welding and the relation between the qualities of welds and the structure and constitution of the steel. These researches are embodied in a series of papers to be presented at the joint meeting of the American Institute of Electrical Engineers and the American Institute of Mining Engineers to be held in February.

In order to continue the research work on welding, which was begun and carried forward under the auspices of the Emergency Fleet Corporation until January 1, plans have been formulated for the formation of a Welding Association through which adequate financial support will be provided for the investigation of this subject.

SECTION ON PRIME MOVERS.

The activities of this Section have been confined largely to general work upon the problems connected with power plants for aircraft. The general subjects covered have been (1) the development of motors with lower weight per horsepower than those now in use, (2) the development of carburetors to maintain high engine efficiency and capacity at all altitudes, (3) the development of means for increasing the power of airplane engines at high altitudes, (4) the development of fuels to increase the efficiency and capacity of the airplane motors. The most important project undertaken by this Section has been the design of a special airplane engine of great promise.

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DIVISION OF CHEMISTRY AND CHEMICAL TECHNOLOGY.

JOHN JOHNSTON, chairman; E. W. WASHBURN, vice chairman.

The chief effort of the Division of Chemistry and Chemical Technology during the year 1918 has been to secure effective cooperation in the investigation and solution of the many pressing problems involving chemistry and chemical technology raised by the war. Much of the time of its officers and committees has been given to service as a clearing house of information and advice in connection with a great variety of problems. In this connection it has been in close touch with nearly all branches of the Government as well as with foreign military and industrial missions and research organizations, and with many private interests, both in this country and abroad. The problems handled in this way have been so numerous and varied in character that even an enumeration of them is impracticable in this place. The committees of the Division and its special consultants have been especially valuable in connection with this work, and it is largely through them that the Division has been able to give the information and advice which has been requested of it.

Owing to the existence of numerous chemical laboratories, either under the immediate control of the Government or connected with the universities and industries of the country, whose resources and staffs were available for research, the Division early reached the conclusion that it was neither necessary nor desirable for it to undertake to carry out investigations itself. Where problems requiring research have been presented to the Division it has therefore been its policy to have these problems taken up by some one of the laboratories already in existence, preferably a Government laboratory, wherever the necessary facilities were available. In order to supplement the work of the Government laboratories and to mobilize as effectively as possible all of the research resources of the country for work upon war problems, the Division has during the last year secured from various governmental agencies concerned with matters involving chemical questions, problems which could not be adequately dealt with under the conditions existing in the governmental laboratories during war time. These problems, of which about 50 had been received when the war ended, were then formulated and assigned for investigation to men in private laboratories or in educational institutions. They cover a very wide range, from investigations of the physical properties of toxic liquids and explosive substances and of methods for combating toxic gases, to studies designed to relieve shortages of necessary materials or to utilize by-products and wastes.

At the request of the War Department's Committee on Education and Special Training the Division prepared a series of recommenda-

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tions for the training of chemists in the Student Army Training Corps, including detailed statements concerning the content of courses, together with special two and three-year war curricula in chemistry and chemical engineering. These recommendations and curricula received the approval of the General Staff, and were in general use at educational institutions having units of the Student Army Training Corps.

ACTIVITIES OF THE COMMITTEES OF THE DIVISION.

Some of the main activities of the committees of the Division may be stated as follows:

1. *Committee on the chemistry of soils and fertilizers.*—This committee prepared a census of the potash needs of the United States for agricultural purposes in 1918, a summary of which was published in the Quarterly Journal of Economics for February, 1918, under the title "The fertilizer needs of the United States." The committee has also urged upon the geological surveys of various States the importance of systematic surveys for the location of potash deposits, especially in connection with deep drilling operations.

A number of Agricultural Experiment Stations have cooperated with the committee in experiments on the availability of phosphoric acid for plant food and of potash in ceresites; likewise in testing the effect of the treatment of seeds before planting; with certain soluble fertilizing ingredients, and in a study of different methods of soil treatment and fertilizing in connection with potato culture.

2. *Committee on the chemistry of rubber and allied substances.*—This committee has investigated the subject of rubber content of certain California shrubs and has been continuously in cooperation with the Quartermaster's Department in the preparation of specifications and standard tests for rubber compounds, with special reference to automobile tires and tubes. It has also carried out investigations on the recovery of cotton from scrap tire fabric and tire waste, and has cooperated in certain rubber work required in connection with the preparation of submarine detectors.

3. *Committee on the chemistry of fuels and combustion.*—This committee has concentrated its efforts in obtaining a better fuel for airplane motors through cooperation with the United States Bureau of Mines and the United States Bureau of Standards, the various aviation fields, and the British War Mission, and the fuels which have shown most promise have been submitted to actual flying tests, both in the United States and abroad.

The Engineering Experiment Station of Purdue University has also cooperated with the committee in an extensive series of tests on

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carburetors for the purpose of determining various losses of efficiency, to ascertain the causes thereof, and to suggest remedies.

4. *Committee on apparatus and supplies.*—This committee has been active in assisting in the location of special types of apparatus and measuring instruments required by different governmental agencies, and in securing the manufacture of certain types of apparatus not otherwise available on the American market.

Some of the subjects to which attention has been given are apparatus statistics, duty free importations for educational institutions, manufacture of certain types of apparatus and measuring instruments for student use, standardization of certain types of apparatus, and preparation of satisfactory descriptions of types of measuring instruments, together with instructions for use.

5. *Committee on the chemistry of ceramics.*—This committee has issued a report outlining projects for a cooperative geological and ceramic survey of ceramic raw materials with a result that a conference including representatives of various Government bureaus, the American Ceramic Society, and the Association of American State Geologists has been held and that a systematic study of the ceramic resources of a number of States is now in progress. The proceedings of this convention have been published.

At the request of the United States Fuel Administration the committee has had prepared a synopsis of a course in chemistry combustion and fuel engineering, and at the request of the War Department a special war curriculum in ceramic engineering was prepared for use by the Students' Army Training Corps.

6. *Committee on synthetic drugs.*—This committee has advised the Federal Trade Commission with regard to licenses under the trading with the enemy act for the manufacture of synthetic drugs by patented processes belonging to the enemy, with a result that the Commission not only requires a recommendation from the committee, but also requires that an applicant for a license submit to the committee a specimen of the drug for which the license is desired to undertake such production.

The committee has also cooperated with the Federal Trade Commission and with the United States Public Health Service in the production of adequate quantities of licensed drugs, in interesting manufacturers of drugs to undertake such production, and in standardizing methods of manufacture and of testing certain drugs. The following specific results may be instanced: Arsphenamine, procaine, and barbital are now being produced in quantity in this country, and a license has been taken out for the manufacture of atophan. Holocaine, euphthalmine, and a long list of unprotected articles are either entirely available or about ready to be marketed, and preparations

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for large-scale production of luminal, a specific for epileptics, are well forward.

7. *Committee on the chemistry of dyestuffs and textiles.*—This committee has cooperated with the War Industries Board and the United States Bureau of Standards in the preparation of standard specifications for the waterproofing of fabrics; a report is in process of preparation. Cooperation with governmental agencies has also been secured in a study of problems connected with dyestuffs and dyed fabrics.

8. *Committee on the chemistry of colloids.*—This committee has cooperated with governmental agencies in the preparation of standard specifications for glues and gelatin.

9. *Committee on chemical engineering.*—This committee has aided effectively in preparing an organization for bringing the services of American chemical engineers more directly and more fully to the aid of the Government.

COMMITTEE ON EXPLOSIVES INVESTIGATIONS.

This joint committee was created July 1, 1918, with the approval of the Secretary of War and the Secretary of the Navy—

(1) To survey the investigations on explosives now under way and to keep closely in touch with their subsequent progress.

(2) To gather and communicate to the proper military and naval authorities all information available in regard to such investigations.

(3) To bring to the attention of the proper military and naval authorities proposals for supplementary investigations relating to explosives, and to arrange for the prosecution of such investigations by the civil bureaus of the Government, by industrial companies, and by universities and endowed research institutions.

The committee was composed of Col. W. C. Spruance, Ordnance, United States Army, nominated by the Chief of Ordnance of the Army; Lieut. Commander T. S. Wilkinson, United States Navy, nominated by the Chief of Ordnance of the Navy; Mr. L. L. Summers, representing the War Industries Board; with Dr. Charles E. Munroe, designated by the National Research Council as chairman.

On the recommendation of the committee, Mr. G. A. Rankin, of the Bureau of Mines, was appointed technical assistant by the National Research Council, while Maj. J. H. Hunter, Ordnance, United States Army, Lieut. (Junior Grade) H. H. Armstrong, United States Navy, and Mr. M. F. Chase, of the War Industries Board, were designated liason attachés for their respective services.

It was decided that to perform the assigned duties a record should be made of the investigations on explosives which were completed or

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in progress; with this object a canvass was made of all the divisions of the Government, of the industrial companies of the United States engaged in the manufacture of explosives, of the universities, and of the private research institutions. It was decided at the outset that the committee should seek only the titles of these investigations, with sufficient data relative to the filing of the reports on them to identify them when sought, and that this information should be carded in such form as to be readily accessible. It is gratifying to report that in every instance the investigators, though connected with manufacturing establishments, have promptly furnished full reports of their investigations. By order the records of the War and Navy Departments relating to explosives investigations were also made available.

The returns from the canvasses made have been most gratifying. This information has been supplemented by the reports from the scientific attachés in London, Paris, and Rome of the investigations made and in progress in Great Britain, France, and Italy sent directly to the National Research Council, and by reports from these sources supplied to the War and Navy Departments. This information is being carded, there having been over 2,500 cards thus far prepared.

As information has been received it has been communicated to the officials of the War and Navy Departments, sometimes by correspondence, but usually through liaison attachés, and it has repeatedly occurred that certain of these reports have been requested as bearing upon the work in hand. Advice and counsel on matters relating to explosives has frequently been sought by many divisions of the Government. Incidentally the committee, through the scientific attachés of the National Research Council, has furnished information requested by the allied Governments.

The committee at its meetings has thoroughly considered the duties set forth in (3) and after a review of the record has assigned subjects for investigation. Some of these investigations have already been reported upon and the results have been considered valuable by the authorities.

COMMITTEE ON NITRATE INVESTIGATIONS.

In May, 1918, the Secretary of War requested the National Research Council to designate two or more research men, to be appointed consulting chemists to the Ordnance Department, and who, together with the officer in charge of the research section of the Nitrate Division, shall constitute a small executive committee whose duties shall be (*a*) to survey the researches now in progress, (*b*) to plan further investigations relating to nitrogen-fixation processes, (*c*) to arrange for the active prosecution of such investigations, and (*d*)

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to exercise close oversight over their progress; the actions taken by this committee and the allotment of funds recommended by it to be subject to the approval of the chief of the Nitrate Division.

This committee was immediately constituted by the National Research Council, with Arthur A. Noyes, chairman of the Nitrate Commission of the War Department, as chairman, and with John Johnston, chairman of the Division of Chemistry and Chemical Technology of the National Research Council, and Lieut. Col. Alfred H. White, in charge of the research section of the Nitrate Division of the Ordnance Department, as the other two members.

During the past year this committee has kept in close touch with all the research and development work in progress under the Nitrate Division. It has specifically been largely instrumental in arranging for the following activities:

1. Through an understanding with the Chief of the Bureau of Chemistry of the Department of Agriculture and the Secretary of that department, the unfinished laboratory of that bureau located at the Arlington Farm was temporarily placed at the disposal of the Nitrate Division, was equipped with the necessary machinery, and was utilized for the study of the production on a semi-industrial scale of the catalyst used in the synthetic ammonia process at United States Nitrate Plant No. 1 at Sheffield, Alabama.

2. By a similar arrangement with the Department of Agriculture the laboratory of the Bureau of Soils at the Arlington Farm and its personnel were temporarily transferred to the Nitrate Division; and the plant already installed there for the testing of catalysts for the synthetic ammonia process was greatly enlarged and improved.

3. An arrangement was made with the director of the Geophysical Laboratory of the Carnegie Institution of Washington, and with the president of that Institution, by which investigations on the cyanide process of nitrogen fixation and on catalysts for the ammonia synthesis were undertaken by the staff of the laboratory, assisted by men appointed by the Nitrate Division. The services of Dr. E. C. Franklin, one of the leading authorities on nitrogen compounds, were secured for this work.

4. An experimental investigation on the principles underlying the absorption of nitrous vapors in water was started at the Massachusetts Institute of Technology, and the process there worked out was afterwards tried out on a semi-industrial scale with successful results at the United States nitrate plant at Sheffield, Alabama.

5. There was actively enlisted in the nitrate research work the interest of Dr. W. R. Whitney, director of the Research Laboratory of the General Electric Co., who gave valuable advice in regard to the nitrogen problems in general and inaugurated experimental work in his own laboratory on catalysts for the ammonia synthesis.

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6. The chairman of the nitrate investigations committee, in company with Mr. C. P. Townsend, was sent to England and France for a period of two months to study the recent developments of nitrogen processes and the researches in progress there.

7. A detailed plan for the organization on a permanent basis of a bureau of research and development to take charge of nitrate investigations was presented to the Assistant Secretary of War.

DIVISION OF GEOLOGY AND GEOGRAPHY.

WHITMAN CROSS, *Chairman.*

The Division was organized early in January under the chairmanship of Dr. J. C. Merriam and succeeded to the work of the committee on geology and paleontology and the committee on geography. These committees were not discharged, but have been retained as advisory bodies on problems of general character. Much of the work of these committees was finished in 1917, but certain projects were further developed by the Division and will appear in the following statement.

The Division has held 29 meetings during the year. It has often called upon geologists and geographers of the country for conferences on special subjects.

GENERAL ACTIVITIES OF THE DIVISION.

1. A report on materials and facilities for rapid road and fortification construction in the coastal States from Maine to Texas was prepared by the Geology Committee, under the immediate direction of W. B. Clark, and completed on his death by Edward B. Mathews. This report has been placed at the disposal of the Chief of Engineers, and a copy has also been deposited with the United States Geological Survey, where it has been consulted by many Government agencies. It has been of especial use in connection with concrete construction work.

2. *Information as to the geology and geography of the environments of Army cantonments and camps in the United States.* At the suggestion of the Geology Committee, Federal State surveys undertook the preparation of bulletins, and several have been published during the year 1918.

3. *Information as to the geography of the western front in Europe.* Portions of the work, Topography and Strategy in the War, by Douglas W. Johnson, dealing with the western front, have been republished in separate form and gratuitously distributed among the officers of the United States Army at the cantonments and camps as

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well as in Europe. This distribution was initiated by the Geology Committee and made possible by the generosity of one of its members. The American Library Association ordered several hundred copies of this separate for use in libraries at camps.

Several thousand copies of the Handbook of Northern France, by Prof. William M. Davis, chairman of the Geography Committee, have been gratuitously distributed among officers of the Army. This was possible through generous contributions secured by the author. The publication was issued at cost by the Harvard University Press and distributed without profit to the author.

4. *The utilization of geologists as experts in the American Army.* A memorandum on the usefulness of geological advice in the operations of an army was presented to the Secretary of War by the Geology Committee in 1917. During the past year the geological war service in the German Army, as described in German literature, has been brought to the attention of the Army authorities, and a considerable development of such service has taken place in our Army. The Division has improved every opportunity to make clear the value of this special service.

5. Maj. Johnson, a member of the division, was able to make important observations concerning geological and geographical work in several of the allied armies and in the German Army, and has submitted important reports upon this subject, which have been transmitted to the War Department.

6. *Instruction in geology, geography, map reading, etc., in training camps and colleges.* An effort to promote work of this kind was initiated by the geology committee in 1917. With the organization of the Students' Army Training Corps the opportunity for developing the desired instruction was offered. At the request of the military Committee on Education and Special Training the Division of Geology and Geography prepared courses in geology, geography, map reading, and meteorology. The evident need for textbooks in these courses was supplied by a special committee of the Division, of which Prof. Herbert E. Gregory was chairman, and the following textbooks were prepared: Military Geology and Topography, Introductory Meteorology, and a syllabus on the geography of Europe. Prof. Gregory acted as the editor of this series of textbooks. Introductory Meteorology was prepared mainly through the hearty cooperation of members of the staff of the United States Weather Bureau.

COOPERATION WITH GOVERNMENT BUREAUS AND OTHER ORGANIZATIONS.

7. *Research Information Service.* The Division has supplied to our allies, through the Research Information Service, a considerable

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amount of information on geological and geographical subjects. This has been carried on through both the London and the Paris offices of the Research Information Service. Information has also been secured from the English, French, and Italian Governments through the Service.

8. *Military Intelligence Division, Office of the Chief of Staff.* The Division has cooperated throughout the year with the Military Intelligence Division to furnish information on geological and geographical subjects.

9. The chairman of the Division has been a member of the Joint Information Board on Minerals and Derivatives and has taken part in the work of that board.

10. The Division has cooperated with the United States Geological Survey, the United States Bureau of Mines, the Fuel Administration, and other boards to secure special reports on subjects pertaining to the mineral and fuel supply of the United States and of foreign countries available for war purposes.

11. The California State Council of Defense has transmitted to this Division a number of reports prepared by its committee on geology and mineral resources, concerning the supply of important war minerals in California. These reports have been utilized by the Division in supplying information to various Government bureaus.

12. *Clear-quartz resources of the United States.* An investigation was made by Dr. G. P. Merrill, as a committee of the Division, as to the clear-quartz resources of the United States with reference to the use of this material in certain instruments. An investigation of quartz appearances in California, by Prof. A. F. Rogers, was made in connection with this report. The expense of both investigations was borne by the Research Council from funds allotted to this Division.

DIVISION OF MEDICINE AND RELATED SCIENCES.

Col. F. F. Russell, M. C., U. S. Army, *Acting Chairman;* Maj. R. G. Hussey, M. C., U. S. Army, *Vice Chairman.*

The present organization of the Medical Division has been in existence since February, 1918, when it was established under the chairmanship of Dr. Richard M. Pearce, who was later assisted by Dr. Peyton Rous, as vice chairman. Previous to this date the medical sciences were represented by several different committees, in accordance with the general plan of the Council's organization at that time. Those existing committees of the original Council, representing sciences concerned with problems dealing with the cause, prevention, and treatment of disease states among the military and war-industry forces, as well as those representing sciences concerned with the mental and physical fitness of individuals for military service,

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were grouped to form a nucleus for the Division of Medicine and Related Sciences. These committees retained their titles and personnel, and the researches then in progress under their direction were continued by them without interference.

In the subsequent development of the Division (see War Organization, p. 107) there has been a constant effort to recognize those applied sciences upon which medical problems are so fundamentally dependent that they are an actual necessity for thoroughness in medical investigation, and to include these in its organization. Investigators in these sciences were and have continued to be enrolled to serve on committees or subcommittees.

In the main the purpose of the Division from the beginning has been to mobilize the civilian medical and related scientific workers and institutions, with their laboratories, in the United States, thus organizing a united scientific medical service for aiding in the solution of problems bearing upon and promoting the efficiency of national defense. This has been accomplished by close cooperative contact with the Surgeon General of the Army, through Col. Russell, with the Surgeon General of the Navy, through Dr. Stitt, and with the most hearty support and cooperation from the many scientific investigators throughout the country.

The general plan has been to follow the advice of representatives of the War, Navy, and Labor Departments in determining urgent problems, and then to find the proper workers to investigate them. The committee plan has been adhered to as far as it has been possible; but there have been many instances where individuals working independently of committees have given their entire time and laboratory facilities to the work on war problems. The committees and subcommittees dealing with such problems, at the time of the signing of the armistice, were constituted as shown on page 107.

Lack of space prohibits any detailed statement of the many problems taken up by the different committees or by individuals working in connection with the Division. However, a word about some of these seems necessary.

1. Much has been accomplished as a result of investigations undertaken to study traumatic shock; although the results have by no means entirely explained the phenomenon, they have given illumination to certain clinical aspects of the problems.

2. Investigations concerned with the control of lice and their eggs, and preventive measures against infestation, have resulted in the development of effective insecticides and methods of delousing.

3. A method has been found for the prevention of post-operative neuromata in amputation stumps.

4. Much attention has been devoted to the cultivation and collection for pharmacological study of native medicinal plants. As a re-

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sult, all of the digitalis now required for use in the Army is grown and tested by scientists at the University of Minnesota.

5. Acetone, a necessary solvent for airplane varnishes, was almost unobtainable in the early months of the war. A simple method has now been worked out for its production and put into practical operation by the Government.

6. The work of the Committee on Industrial Poisonings has brought to light facts of great importance, which have resulted in steps being taken to protect the health of munitions plant workers.

7. Investigations concerning the cause and prevention of the existing epidemic disease ("influenza") have been encouraged and supported to the fullest extent. It is at this time too early to make any statements regarding results, but it is hoped that in the near future some important facts will be forthcoming.

The following list gives by title only the complete roster of researches commenced. Many of these have been completed and papers on the results have either been published in journals or are official documents in the files of the Council.

A. *Under direction of the Executive Committee of the Division:*

1. The development of protectors for the ear against effects of high explosives.[1]

2. New methods for the production of acetone.[1]

3. General testing of new antiseptics and special study of application of the same (2 stations).[1]

4. Studies of anaerobic bacteria of importance in war wounds (3 stations).[1]

5. The cultivation, collection and pharmacological study of native medicinal plants (3 stations).[1]

6. Determination of substitutes for ambrine.[1]

7. A study of gases as disinfectants of wounds and their use to render disease carriers innocuous.[1]

8. Sterlization of drinking water for large bodies of troops.[1]

9. A critical study of methods of small-pox vaccination on a large scale.[1]

10. The value of the agglutination test after vaccination against typhoid fever.[1]

11. A study of rare and unusual sugars in the different strains of pneumococcus, streptococcus, and meningococcus.

12. A study of hemostatic preparation.[1]

13. Studies of peripheral nerve injury and repair, with special reference to the prevention of amputation neuromata.

14. Studies of streptococcus infection, with special reference to empyema.

15. A study of possible substitutes for the petri dish.

16. War (?) edema among infants.

17. Chemotherapeutic studies of experimental pneumococcus infection.

18. Tests to devise a gauze mask effective in the prevention of droplet infection.

19. A study of the cause of the so-called Spanish influenza and its possible prevention by vaccination.

[1] Research in progress under the direction of the Committee on Medicine and Hygiene as constituted in the original organization of the Council (Col. Victor Vaughan, chairman).

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20. Tests of the influence of slow intravenous injections of foreign serum in the prevention of anaphylactic shock with special reference to the army use of antitoxic sera.

21. Chloralose as a general anesthetic in cases of shock.

22. Skin grafting as conditioned by the blood group of donor and recipient.

23. The use of "immunized" skin grafts in infected wounds.

24. Gentian violet as an antiseptic for "preserved blood" used in transfusions.

25. Methods to increase the yield of serum-antibodies in immunized animals.

26. A simplified and improved apparatus for transfusions.

27. A study of the importance of antiagglutinins for transfusion.

28. A test to disclose oxygen-lack in the air of submarines and mines.

B. *Committee on industrial poisonings:*

1. An experimental study of toxic effects of substances entering into the manufacture and handling of explosives. (1 station, 7 workers.)

2. A study of early signs of intoxications among munitions workers. (8 field workers in 6 munitions plants.)

3. A study of airplane "dopes."

4. The development of protective varnishes or other skin coverings.

C. *Committee on toxicity of preserved foods:*

1. Studies of canning and other methods of preserving food.[1]

2. The related problems of botulism.

D. *Committee on neurology and psychiatry:*

1. An analysis of 13,000 records of soldiers discharged from service on account of nervous and mental disturbances.

2. The early histological lesions of meningoencephalitis. (From material of the Army Medical Museum.)

E. *Committee on the study of the physiology of shock:*

1. Twenty-nine studies in 10 stations.

F. *Committee on control of hemorrhage* (3 stations).

G. *Committee on fatigue in industrial pursuits:*

1. An investigation of hygienic conditons in industrial establishments.

2. Studies of industrial efficiency.

3. Physiological studies of fatigue.

H. *Committee on Biochemistry:*

1. Studies of varieties of velvet bean and of its utilization as a food.

2. Substitutes for cane sugar.

3. The minimum vitamin requirement.

4. Substitutes for acetone in extracting and drying.

I. *Anthropology committee:*

1. A study of central European races in New York City.

2. Race in relation to physical conditions and fitness for employment.

3. Anthropometric study of drafted men.

J. *Psychology committee:*

1. Twenty studies by 12 different observers (or groups of observers) of military problems to which the methods of psychology are applicable.

K. *Medical zoology:*

1. Studies of Giardia Microti.

2. The treatment of experimental Giardiasis.

3. An improved method of detecting ova of parasites in stools.

4. Hookworm investigations.

5. Louse investigation[1] (3 stations—numerous studies).

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[1] Researches in progress under the direction of the Committee on Medicine and Hygiene as constituted in the original organization of the Council (Col. Victor Vaughan, chairman).

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In addition to these more specific activities, the Division has rendered many miscellaneous services, some of which may be briefly stated. Medical and premedical schools have been canvassed, soliciting their cooperation in making certain changes in their curriculum to meet the necessities of war medicine and surgery and the Army Laboratory Service. Letters were sent to all colleges and universities, recommending the character of work best suited for their departments of bacteriology and biology, to fit students for training in the Army Laboratory School in the event of such students being inducted into the Army Laboratory Service. Pathologists and bacteriologists have been procured for the Army Medical Corps.

Conferences between civilian investigators, representatives of the Surgeon General's Office, and the Council have been arranged and the traveling expenses paid in instances where there was no provision by the Government to meet such expense. Bibliographies on medical themes have been prepared and distributed to military hospitals and individuals carrying on war investigations. The cooperation of Col. Garrison, of the Surgeon General's Library, has allowed us to furnish photostatic reprints of articles from German journals published during the war, and in this way it has been possible to disseminate very valuable information in many subjects of importance. Breeding stations for white mice have been organized in different parts of the United States so that the hospital laboratories would not be hampered in pneumonia diagnosis by a lack of these animals. When the present epidemic disease ("influenza") appeared the Division made every effort to assist when and however it could.

Because of the relative independence in the Division of the Psychology Committee and the Committee on Anthropology, special statements prepared by their respective chairmen are given here.

1. *Committee on psychology.*—The Psychology Committee of the Council was appointed in April, 1917, and functioned as an independent committee until it was constituted, in March, 1918, a part of the Division of Medicine and Related Sciences. The committee has worked chiefly through subcommittees and military appointees in the Army and Navy, and the success of its work has been clearly shown by the increase in demands for psychological service and the rapid extension of the several lines of psychological work which have been organized in military departments.

One of the most interesting facts concerning the work of this committee during the war is the great preponderance of service over research. In the numerous reports which have been issued there is much of permanent scientific value, but by contrast the emphasis seems to be placed continuously upon the immediate service of technological materials.

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The services of this section of the Council have touched and more or less modified almost every aspect of military personnel work. The committee on classification of personnel in the Army was indirectly a result of the organization of the psychological military service by the American Psychological Association and the National Research Council.

For the Division of Military Aeronautics the committee has also prepared tests of mental alertness for enlisted men, providing for the measurement of those characteristics of mind and behavior which are important in the aviation service. The contributions of psychologists to the study of qualifications for flying, the fitness of flyers, and the psychological effects of high altitudes are conspicuously important.

The committee has aided the Division of Psychology of the Medical Department of the Army to administer mental tests to enlisted men and commissioned officers in accordance with plans perfected in 1917. This work entailed the establishment of a special school for training in military psychology at Fort Oglethorpe, Ga., in which more than 400 men were trained.

The rating of soldiers according to mental alertness or degree of intelligence has facilitated the early and prompt elimination of men who are mentally unfit for service and the proper utilization of various grades of intelligence. Approximately 1,700,000 individuals have been examined to date.

The establishment by the War Department of the morale branch of the General Staff was greatly facilitated, if not primarily due to the interest and efforts of members of the Psychology Committee.

It has been demonstrated that psychological methods could be devised and adapted to assist in selecting and training observers and scouts, and to this end a series of tests of mental alertness has been prepared for the Division of Military Intelligence.

A special subcommittee was organized to assist the Committee on Education and Special Training of the War Department to adapt instruction in psychology to the needs of the Special Activity Training Camp. Mental tests for the rating of students were also prepared.

For the United States Navy, the Psychology Committee has engaged in the selection of suitable lookouts for merchantmen, the selection of men for special assignment in gunfire squads, and the selection of candidates for training as "listeners." Although the Navy has not utilized the methods of mental testing employed by the Army, assistance has been rendered by this committee to the Navy in connection with the rating, classifying, and assigning of men according to their mental capacity.

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Other investigations have been undertaken dealing with problems whose solution is particularly significant in connection with submarine warfare and aviation and a method has been devised for detecting those men whose emotional constitution is such as to warrant careful neuropsychiatric examination.

Important psychological problems in military training have also been attacked by the committee. A study of disciplinary problems for the assistance of the Medical Department and the morale branch of the General Staff has been undertaken, and much practical work in the interests of mental reeducation has been carried on.

2. *Committees on anthropology.*—Shortly after the organization of the Division, it was recommended by the members of the original Committee on Anthropology to abolish that committee as it was then constituted and to have the anthropological work divided into three sections as they are now represented. It was planned to conduct investigations aimed at perfecting methods of selecting men for and arranging men in military service. A plan of procedure was formulated for making investigations to obtain information that might serve as a basis for further developments in this work. Many of the larger projects in the plan were not realized on account of unexpected and untimely adverse circumstances. However, those investigations planned to be carried on by the individual members of the committee were accomplished, and as a result important recommendations were made to the War Department.

Dr. Davenport was commissioned in the Sanitary Corps of the Army and put in charge of the Section of Anthropology in the Surgeon General's Office, which section was organized along lines suggested by him. In this capacity he made several trips to different camps for the purpose of inspecting methods for making physical examinations, and as a result of such observations changes for improvement were recommended and adopted. The Army standard physical examination form (1010 P. M. G. O.) was revised to include data recording color, occupation, and nationality of registrants. The minimum stature of 63 inches for acceptance in general military service was recommended to be reduced to 60 inches. This change was adopted in June, 1918.

Later Dr. Davenport was put in charge of the statistical work in the Section of Medical Records and at the present time is serving in this office. Very careful examination is being made of data regarding height, weight, chest measurements, and incidence of various defects and diseases found by local draft boards as well as by camp examining boards. These records are being classified with reference to the part of the country from which the individual originates in accordance with a division of the total area of the United States in 157 sections, based primarily upon the racial con-

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stitution of the population of these. Each group of statistics will be treated separately and the results published later. One paper on the relative disease incidence in white and colored troops, by Dr. Davenport and Col. Love, has been sent to the National Academy of Science for publication in its Proceedings.

The plan for securing anthropological information on a broad scale was interfered with first by the temporary abandonment of mobilization when the epidemic disease ("influenza") became so prevalent in September, and following this by the complete cessation of mobilization when hostilities ceased. Despite these facts Dr. Hoffman was able to obtain some records at Hog Island. Plans were presented for carrying on this work during demobilization, but these were not approved by the General Staff.

The financial support for the activities of the Division of Medicine and Related Sciences was obtained from the Rockefeller Foundation. A grant of $50,000 was made to be expended by the Division for war work, although only a relatively small portion of this was used. In addition to this grant, there were two donations made by Maj. W. W. Keen, M. C., of $382.22 and $101.74, royalties from a book entitled "The Treatment of War Wounds," written by Maj. Keen at the suggestion of the Council. Later, when the plans for the Division's activities during demobilization were presented to the Foundation, it made a further grant of $15,000 to support them.

In conclusion, the executive committee of the Medical Division wishes to pay tribute to the many scientific workers throughout the country who have given their services untiringly and unstintingly to the cause for which all have worked during the war. That their efforts have met with success is attested to by many testimonials of thanks and appreciation from the heads of the different divisions of the War, Navy, and Labor Departments whose problems they have endeavored to solve. Also, it wishes to record an expression of appreciation for the thoughtfulness and generosity of Maj. Keen in making his donations to the funds of the Division. The depth of its expression of appreciation to the Rockefeller Foundation can best be stated in acknowledging that without its support any effort to accomplish the purposes of the Division would have been most difficult.

DIVISION OF BIOLOGY.

VERNON KELLOGG, *Chairman;* A. F. WOODS, *Vice Chairman.*

This Division has undertaken primarily to establish the necessary cooperation in handling problems which fall within the scope of its constituent committees. Most of the problems which have been considered are of permanent value and are not confined merely to the period of the war, and many of the investigations will cover a period of several years. Besides initiating various investigations the Division has also provided for the affiliation of individual organizations

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when desirable, such affiliation to cease as soon as the problem in hand has been solved.

Information and suggestions have been furnished to the War Department upon sources of material for making charcoal for gas masks and the possible use of animals as indicators of the presence of poison gases in the air and upon possible uses for ammonium nitrate if this product can be economically manufactured in large nitrate fixation plants.

It has also been ascertained by the Division that other native woods are better suited for airplane propellers than African mahogany, with a result that orders for the importation of this wood were canceled and thousands of tons of shipping thus saved.

In addition, the following projects have been undertaken by this Division:

Fertilizers.—A cooperative group of soil and fertilizer specialists from North and South Dakota, Minnesota, Wisconsin, Iowa, Nebraska, Kansas, and Missouri has been organized for the purpose of studying the fertilizer problems of that great agricultural region and the special cooperation of the Department of Agriculture has been secured for a further study of the problems involved.

Poultry feeding.—Experiments have been carried on to determine the presence or absence in poultry food of certain substances influencing egg production, and a cooperative study among poultrymen in the East and West has been secured. Results so far obtained have confirmed the value of certain empirically established methods of feeding.

Protein metabolism in animal feeding.—Emphasis in this investigation has been placed upon the quality of the protein consumed, the influence of accessory substances and the variation in the ash of the rations. The method of procedure has been to feed beef or dairy calves old enough to consume exclusive dry feed upon two different planes of protein intake but with equal net energy supply. A conference has been arranged to bring together the investigators cooperating in this work, but final results are not as yet available.

Rats, mice, and rodent pests.—In cooperation with the United States Biological Survey a campaign has been started in the United States, through the State Councils of Defense and other organizations, for the rat-proofing of buildings, for cleaning up harboring places, such as trash piles and wooden sidewalks, and for the poisoning of rats. It is estimated that there are over 100,000,000 rats in the United States and that each rat will do at least $2 worth of damage in a year. This campaign, which is continuing, is mainly concerned in drawing attention to the seriousness of the situation. Similarly, in cooperation with the United States Biological Survey, an investigation has been made of the relation of rodent pests

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to their environment, especially with reference to forage and grain crops.

Physiological salt requirements of representative cultivated plants.—A special committee has this subject in charge and various institutions in the country have been visited for the purpose of presenting the problem as an opportunity to cooperate on the application of physiology to agriculture. About half of the standard institutions in the United States are cooperating in the project, and a prospectus has been prepared so that all investigators may follow the same methods and use the same materials.

Sizing materials.—Under the supervision of the United States Bureau of Fisheries a study of the availability of alginic acids for sizing materials has been instituted in view of the scarcity of ordinary sizing materials and the desirability of avoiding any substitute which would decrease the food supply.

Salting fish in southern climates.—Also under the auspices of the United States Bureau of Fisheries, an investigation has been undertaken relative to the possibility of overcoming the processes of decomposition which normally take place in salting fish in southern climates.

Lac and lac insects, mesquite gum.—In view of the existing conditions it seemed that the possibility of developing a domestic source of supply of lac, better known by its commercial name "shellac," should not be neglected. Results showed that in regions where lac is most abundant the supply at present is insufficient for even the most remote commercial possibilities. Mesquite gum was found in negligible quantities.

War emergency board of plant pathologists.—The division has cooperated in the work of propaganda and investigation undertaken by this board, and an appropriation was made to facilitate and encourage the work of the board. The project brought together the leading plant pathologists of the country for the purpose of considering the most effective means of controlling diseases of various food crops, and the results accomplished have not only been of great value from a scientific point of view but from the standpoint of the practical control of diseases as well.

Instruction in universities.—Upon the request of the War Department the Division undertook to formulate courses in biology, protozoology, animals in relation to disease, plant pathology, botanical raw products, and wood inspection for the Students' Army Training Corps. While it is believed that the outlines suggested were helpful in many cases, the continuance of the courses was for so short a period that their value and educational effect could not well be determined. The results of this experience, however, will not be lost.

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PUBLICATIONS.

Hitherto the results of the work of the National Research Council have been widely scattered, appearing in books, reports, articles, in scientific and technical journals, and other publications. The executive board has now decided to issue a series of Bulletins, early numbers of which will contain the following reports and papers:

Report of the Psychology Committee.

Report of the Patent Committee.

Provisional Prospectus of a Zinc Research Association.

Provisional Prospectus of a Ceramics Research Association.

National importance of scientific and industrial research.

Jewett, Frank B.: Industrial Research.

Russell, Henry N.: Some Problems in Sidereal Astronomy.

Washburn, Edward W.: Refractory materials as a field for research.

ACKNOWLEDGMENT.

The chairman of the National Research Council, in concluding nearly three years of service, wishes to express his very cordial appreciation of the unwavering interest in the work of the Council and the steady devotion to its objects which have characterized his many colleagues. Most of them have worked with little or no compensation under the trying conditions of the war emergency, and frequently at great personal inconvenience. The progress that has been made under such circumstances and the unflagging purpose which still animates all who are taking part in the work, even after the war stimulus has been removed, augur well for the future. Special mention should be made of the important contribution of Messrs. Millikan, Noyes, and Merriam, who have served as Acting Chairman during the absence of the Chairman. I wish that it were feasible here to name every one of the hundreds who have aided the Council, both at home and abroad, and to make adequate reference to his or her contribution to the work.[1] Each will find satisfaction in the help given in the prosecution of the war and in preparing the way for the future promotion of research. We have only begun a task of unlimited possibilities, and we may look forward with the keenest interest to its continuation and wide development by our successors.

GEORGE E. HALE, *Chairman.*

REPORT OF THE TREASURER, NATIONAL RESEARCH COUNCIL, FOR THE CALENDAR YEAR 1918.

The work of the National Research Council during 1918 was supported by funds coming from several sources and disbursed in various ways, as indicated in the following statement:

[1] It is expected that detailed reports will be published by the various Divisions of the Council.

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1. Grants from the Carnegie Corporation of New York, through the Carnegie Institution of Washington, for general expenses of office, maintenance, and special investigations, disbursed by the treasurer of the National Research Council from a special account; $50,000 appropriated in June, 1917; $100,000 for the fiscal year July 1, 1918, to June 30, 1919.

2. Grant of $50,000 from the Rockefeller Foundation of New York for the support of the Division of Medicine and Related Sciences for the period from March 1 to December 31. This fund was given to the National Academy of Sciences and has been disbursed by its treasurer from a special account.

3. Miscellaneous funds given to the National Academy of Sciences for the support of the National Research Council.

4. Allotments from the President's emergency appropriation, for general office expenses of the Council, and the expenses of the Research Information Service, disbursed through the Council of National Defense; $29,500 for the period from January 1 to June 30; $61,000 for the period from July 1 to December 31.

5. Special appropriation of $15,000 from the Ordnance Bureau of the War Department for the development of a new type of gun by the National Research Council.

Owing to the various methods of disbursement of the funds the expenditures for the work of the Council during the first six months of 1918 were not completely classified except for the Division of Medicine. A budget system, however, classifying all expenditures and unifying all disbursements for the purpose of a general statement was put into operation on July 1. A summary statement for the last six months under that system is given below.

The divisional expenses are paid by the treasurer on the presentation of accounts duly approved by the chairman of the division concerned and countersigned by the secretary of the Council.

STATEMENT OF RECEIPTS AND DISBURSEMENTS, JAN. 1 TO DEC. 31, 1918.

A summary of all receipts and disbursements for the entire year, arranged in sections corresponding to the main sources of revenue above named, is as follows:

RECEIPTS.

I. Carnegie Corporation fund:		
Jan. 1, balance in bank	$2,619.92	
Amount received in 1918	50,000.00	
		$52,619.92
II. Rockefeller Foundation fund:		
Amount received during year	23,856.82	
Bank interest on deposits	114.25	
		23,971.07

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III. National Academy of Sciences, miscellaneous fund:		
Jan. 1, balance	$2,389.35	
Maj. W. W. Keen, M. C., two donations	483.96	
Interest on investments	51.53	
		$2,924.84
IV. Expenses met by Council of National Defense		70,936.10
V. Expenses met by Bureau of Ordnance, War Department		9,150.42
VI. Refund on account of advances		4,895.53
		164,497.88

DISBURSEMENTS.

I. Grant from Carnegie Corporation	55,580.25
II. Grant from Rockefeller Foundation	15,955.35
III. National Academy of Sciences	
IV. By Council of National Defense	70,936.10
V. By Ordnance Bureau in development of Centrifugal gun	9,150.42
	151,622.12
Balance, Dec. 31	12,875.76
	164,497.88

NOTE.—The disbursements include advances from Research Council funds made under emergency conditions, the amounts being returnable from Government funds. The largest of these advances were in connection with the establishment of the London, Paris, and Rome offices of the Research Information Service.

RECEIPTS AND DISBURSEMENTS FROM JULY 1 TO DEC. 31, 1918.

RECEIPTS.

Appropriations:		
Rockefeller Foundation	$12,433.19	
Carnegie Corporation of New York	30,000.00	
Government—		
National Research Council	28,028.46	
Centrifugal gun	6,739.29	
		$77,200.94
Interest:		
On bank deposits	114.25	
On investments	26.53	
		140.78
Refunds		1,696.42
June 30, 1918, balance		14,571.25
		93,609.39

DISBURSEMENTS.

Divisions:		
General relations	$1,393.03	
Military	7,547.59	
Engineering	16,968.27	
Physics	1,543.42	
Chemistry	4,644.66	
Geology and geography	945.68	
Medicine	14,370.89	
Agriculture	3,346.35	
		50,759.89

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Executive board		$49.68
Contingent		2,346.29
General and office expenses:		
Salaries	$18,439.22	
Office expenses	3,578.62	
Rent, fuel, etc	5,559.93	
		27,577.77
Cash in banks:		
Rockefeller fund	8,015.72	
Carnegie Corporation	1,935.20	
National Academy of Sciences	2,924.84	
		12,875.76
		93,609.39

WAR ORGANIZATION.

AS OF OCTOBER 31, 1918.

OFFICERS.

GEORGE E. HALE.....*Chairman.*
CHARLES D. WALCOTT.....*First Vice Chairman.*
GANO DUNN.....*Second Vice Chairman.*
R. A. MILLIKAN.....*Third Vice Chairman.*
JOHN JOHNSTON.....*Executive Secretary.*
WHITMAN CROSS.....*Treasurer.*
PAUL BROCKETT.....*Assistant Secretary.*
ALFRED D. FLINN.....*Assistant Secretary.*

EXECUTIVE BOARD.

JOHN J. CARTY.....*Chairman.*

Ex-officio members.

Officers of the Council, chairmen, and vice chairmen of divisions; the chairmen of the sections of the General Relations Division.

Elected members.

MARSTON T. BOGERT.
WALTER S. GIFFORD.
VAN H. MANNING.
MICHAEL I. PUPIN.
WILLIAM H. WELCH.
ROBERT S. WOODWARD.

INTERIM COMMITTEE.

A. A. NOYES, *Chairman.*

WHITMAN CROSS.
GANO DUNN.
GEORGE E. HALE.
H. M. HOWE.
JOHN JOHNSTON.
VERNON KELLOGG.
J. C. MERRIAM.
R. A. MILLIKAN.
R. M. PEARCE.
C. D. WALCOTT.

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I. DIVISION OF GENERAL RELATIONS.

A. A. NOYES, *Chairman.*

Advisory Committee.

THEODORE N. VAIL, *Chairman.*

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GEORGE EASTMAN.
E. H. GARY.
A. W. MELLON.
PIERRE S. DU PONT.
H. S. PRITCHETT.
EDWIN W. RICE, Jr.
ELIHU ROOT.
AMBROSE SWASEY.

Sections:

FOREIGN RELATIONS, GEORGE E. HALE, *Chairman.*

INDUSTRIAL RESEARCH, JOHN JOHNSTON, *Chairman.*

RELATIONS WITH EDUCATIONAL INSTITUTIONS AND STATE COMMITTEES, J. C. MERRIAM, *Chairman.*

Committees:

PATENT OFFICE COMMITTEE, L. H. BAEKELAND, *Acting Chairman.*

COMMITTEE ON RECONSTRUCTION PROBLEMS, VERNON KELLOGG, *Chairman;* F. H. NEWELL, *Vice Chairman.*

SPECIAL COMMITTEE ON EDUCATION AND SPECIAL TRAINING, J. C. MERRIAM, *Chairman.*

II. MILITARY DIVISION.

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S. W. STRATTON, *Vice Chairman,* Director, United States Bureau of Standards.

CARL L. ALSBERG, Chief, Bureau of Chemistry, United States Department of Agriculture.

WILLIAM S. BENSON, Admiral, United States Navy, Chief of Naval Operations.

WILLIAM S. BLACK, Major General, United States Army, Chief of Engineers.

MARLBOROUGH CHURCHILL, Brigadier General, United States Army, Division of Military Intelligence.

RALPH EARLE, Rear Admiral, United States Navy, Chief, Bureau of Ordnance.

WALTER S. GIFFORD, Director, Council of National Defense.

WILLIAM C. GORGAS, Major General, United States Army, Surgeon General.

ROBERT S. GRIFFIN, Rear Admiral, United States Navy, Engineer in Chief.

HENRY S. GRAVES, Chief, Forest Service, United States Department of Agriculture.

P. D. LOCKRIDGE, Brigadier General, United States Army, Head of Division of War Plans, General Staff.

VAN H. MANNING, Director, United States Bureau of Mines.

CHARLES F. MARVIN, Chief, United States Weather Bureau.

WILLIAM L. SIBERT, Major General, United States Army, Director of Chemical Warfare Survey.

GEORGE O. SMITH, Director, United States Geological Survey.

GEORGE O. SQUIER, Major General, United States Army, Chief Signal Officer.

DAVID W. TAYLOR, Rear Admiral, United States Navy, Chief Constructor.

ROGER WELLES, Rear Admiral, United States Navy, Director of Naval Intelligence.

CLARENCE C. WILLIAMS, Brigadier General, United States Army, Chief of Ordnance.

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RESEARCH INFORMATION SERVICE.

PRESENT ORGANIZATION.

COMMITTEE IN CHARGE:

The Chief of the Division of Military Intelligence, Brig. Gen. MARLBOROUGH CHURCHILL.

The Director of Naval Intelligence, Rear Admiral ROGER WELLES.

The chairman of the National Research Council, or representative designated by him, who acts as general executive officer of the Research Information Service.

WASHINGTON BRANCH:

Officers:

Executive secretary, GRAHAM EDGAR.
Representative of physics and engineering, F. C. BLAKE.
Representative of chemistry and chemical technology, GRAHAM EDGAR
Representative of medicine and related sciences, R. M. PEARCE.

Representatives of Army bureaus:

Division of Military Aeronautics, Capt. A. AMES.
Military Intelligence, Capt. CARL KINSLEY.
Bureau of Ordnance, Maj. C. J. BROWNE.
Quartermaster General's Office, Maj. W. F. DODD.
Office of the Signal Corps, Capt. G. F. GRAY.
Chemical Warfare Service, Maj. S. P. MULLIKEN.
Tank Corps, Capt. PHIL D. POSTON.
Engineer Corps, Capt. L. D. ROWELL.
Office of Surgeon General, Col. F. F. RUSSELL.

Representatives of Navy bureaus:

Office of Naval Intelligence, Lieut. Commander H. H. WHITTLESEY.
Bureau of Steam Engineering, Lieut. M. PENDLETON.
Bureau of Construction and Repair, Capt. W. G. DUBOSE.
Operations—Aviation, Ensign A. F. LIPPMANN.
Bureau of Ordnance, Ensign C. L. MCCREA.

Representatives of civilian bureaus:

War Industries Board, ———.
National Advisory Committee for Aeronautics, W. C. SABINE.
Bureau of Standards, F. J. SCHLINK.
Bureau of Mines, F. G. COTTRELL.
Bureau of Chemistry, H. D. GIBBS.
Explosive Investigations Committee, C. E. MUNROE.
Nitrate Investigations Committee, JOHN JOHNSTON.

Representatives of foreign missions:

British Embassy and war mission.
French Embassy and war mission.
Italian Embassy and war mission.
Japanese Embassy and war mission.
Canadian war mission.

LONDON BRANCH: The military attaché; the naval attaché; the scientific attaché, H. A. BUMSTEAD; engineering associate, S. J. FARNSWORTH; chemical associate, ——.

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PARIS BRANCH: The military attaché; the naval attaché; the scientific attaché, W. F. DURAND; physical associate, K. T. COMPTON; chemical associate, ——; medical associate, R. G. PERKINS.

ROME BRANCH: The military attaché; the naval attaché; the scientific attaché, S. L. G. KNOX; physical associate, EDGAR BUCKINGHAM; chemical associate, H. S. WASHINGTON.

III. DIVISION OF ENGINEERING.

HENRY M. HOWE, *Chairman.*
W. J. LESTER, *Vice Chairman.*

EXECUTIVE COMMITTEE.

C. A. ADAMS.
HENRY M. HOWE.
W. J. LESTER.
L. S. MARKS.
K. E. STUART.
BRADLEY STOUGHTON.

ADVISORY COMMITTEE.

ARTHUR A. HAMMERSCHLAG,	Officially representing the	General Staff, United States Army.
VAN H. MANNING,		United States Bureau of Mines.
POPE YEATMAN,		War Industries Board.
D. W. BRUNTON,		Naval Consulting Board.
AMBROSE SWASEY,		Engineering Foundation.
GEORGE S. WEBSTER,		American Society of Civil Engineers.
PHILIP N. MOORE,		American Institute of Mining Engineers.
JOHN R. FREEMAN,		American Society of Mechanical Engineers.
C. A. ADAMS,		American Institute of Electrical Engineers.
A. A. STEVENSON,		American Society for Testing Materials.
W. B. PRICE,		American Institute of Metals.
EDWARD P. HYDE,		Illuminating Engineering Society.

W. H. BURR.
GANO DUNN.
F. B. JEWETT.
L. B. STILLWELL.
GEORGE C. STONE.
W. R. WALKER.

F. M. WARING.

SECTIONS.

1. Prime movers, L. S. MARKS, *Chairman.*
2. Mechanical engineering, W. J. LESTER, *Chairman.*
   Committee: Fatigue of metals, H. F. MOORE, *Chairman.*
3. Metallurgy, BRADLEY STOUGHTON, *Chairman.*
   Committees:
   - Helmets and body armor, Maj. BASHFORD DEAN, *Chairman.*
   - Ferroalloys, J. E. JOHNSON, Jr., *Chairman.*
   - Steel ingot, Lieut. Col. WILLIAM P. BARBA, *Chairman.*
   - Pyrometer, GEORGE K. BURGESS, *Chairman.*
   - Improvement of metals by treatment at blue heat. ZAY JEFFRIES, *Chairman.*
4. Electrical engineering, C. A. ADAMS, *Chairman.*
   Committee jointly under metallurgy and electrical engineering: Electric welding research, H. M. HOBART, *Chairman.*

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IV. DIVISION OF PHYSICS, MATHEMATICS, ASTRONOMY, AND GEOPHYSICS.

R. A. MILLIKAN, *Chairman.*
C. E. MENDENHALL, *Vice Chairman.*

EXECUTIVE COMMITTEE.

Physics.—J. S. AMES, C. E. MENDENHALL, R. A. MILLIKAN, E. F. NICHOLS, W. C. SABINE, S. W. STRATTON.
Astronomy.—H. N. RUSSELL, FRANK SCHLESINGER.
Geophysics.—L. A. BAUER, A. L. DAY, C. F. MARVIN.
Mathematics.—F. R. MOULTON, R. S. WOODWARD.

COMMITTEES.

1. Physics committee, R. A. MILLIKAN, *Chairman.*
   Subcommittees:
   - Airplane instruments, C. E. MENDENHALL.
   - Arc-light problems, C. G. ABBOT.
   - Balloon problems, H. N. DAVIS.
   - Bomb sights and stabilizers, A. W. DUFF.
   - Camouflage, M. LUCKIESH.
   - Crystal detectors, WALTER G. CADY.
   - Illumination, J. T. TATE.
   - Location of invisible aircraft, G. W. STEWART.
   - Location of mining and tunneling operations, H. A. WOOD.
   - Monoculars and binoculars, E. P. HYDE.
   - Muzzle velocity of projectiles, PAUL KLOPSTEG.
   - Naval range finders, A. A. MICHELSON.
   - Navigation of airplanes, H. N. RUSSELL.
   - Optical signaling, R. W. WOOD.
   - Parachute problems, W. J. LESTER.
   - Photo receiving, JOEL STEBBINS.
   - Pressures in sound waves, D. C. MILLER.
   - Range finders for antiaircraft service, G. B. PEGRAM.
   - Sound ranging, E. B. ROSA.
   - Static charges on airships, G. S. FULCHER.
   - Submarine investigations (several groups), ERNEST MERRITT, MAX MASON, M. I. PUPIN, H. J. RYAN.
   - Submarine mines, E. F. NICHOLS.
   - Upper-air problems, W. R. BLAIR.
   - Use of high pressure in manufacturing guns, P. W. BRIDGMAN.
   - Visibility, F. A. SAUNDERS.
   - Wireless, F. B. JEWETT.
2. Mathematics committee, E. H. MOORE, *Chairman.*
3. Astronomy committee, E. C. PICKERING, *Chairman;* H. N. RUSSELL, *Vice Chairman.*
4. Commiteee on optical glass, A. L. DAY, *Chairman.*
5. Committee on navigation and nautical instruments, L. A. BAUER, *Chairman.*

V. DIVISION OF CHEMISTRY AND CHEMICAL TECHNOLOGY.

JOHN JOHNSTON, *Chairman.*
E. W. WASHBURN, *Vice Chairman.*

H. D. GIBBS, Bureau of Aircraft Production.
C. L. ALSBERG, Bureau of Chemistry.

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C. L. PARSONS, Bureau of Mines.
W. F. HILLEBRAND, Bureau of Standards.
W. D. BANCROFT, E. P. KOHLER, A. B. LAMB, Chemical Warfare Service, research division.
M. T. BOGERT, S. A. TUCKER, Chemical Warfare Service.
A. A. NOYES, nitrate division, Ordnance Department.
GRAHAM EDGAR, research information service.
WILLIS R. WHITNEY, research laboratory, General Electric Co.

COMMITTEE ON NITRATE INVESTIGATIONS, APPOINTED AT THE REQUEST OF THE SECRETARY OF WAR.

A. A. NOYES, *Chairman.*
JOHN JOHNSTON.
A. H. WHITE (lieutenant colonel, nitrate division, Ordnance Department).

COMMITTEE ON EXPLOSIVES INVESTIGATIONS, APPOINTED AT THE REQUEST OF THE SECRETARIES OF WAR AND NAVY.

CHARLES E. MUNROE, *Chairman.*
W. C. SPRUANCE, jr., lieutenant colonel, Ordnance Department.
L. L. SUMMERS, War Industries Board.
T. S. WILKINSON, lieutenant commander, United States Navy.

SPECIAL COMMITTEES.

1. Chemical apparatus and supplies, ARTHUR H. THOMAS, *Chairman.*
2. Chemistry of ceramics, EDWARD W. WASHBURN, *Chairman.*
3. Chemistry of textiles and fabrics, J. MERRITT MATHEWS, *Chairman.*
4. Chemistry and technology of glass, ARTHUR L. DAY, *Chairman.*
5. Chemistry of fuels, E. R. WEIDLEIN, *Chairman.*
6. Chemistry of colloids, JEROME ALEXANDER, *Chairman.*
7. Chemistry of soils and fertilizers, HOMER J. WHEELER, *Chairman.*
8. Synthetic drugs, JULIUS STIEGLITZ, *Chairman.*
9. Chemical engineering, CHARLES F. MCKENNA, *Chairman.*
10. Chemistry of rubber and allied substances, DAVID SPENCE, *Chairman.*

SPECIAL CONSULTANTS.

1. Analytical chemistry, WILLIAM F. HILLEBRAND.
2. Carbohydrate chemistry, CLAUDE S. HUDSON.
3. Chemistry of cellulose and paper, ARTHUR D. LITTLE.
4. Chemistry of cements and related building materials, PREVOST HUBBARD.
5. Chemistry of explosives, ARTHUR M. COMEY.
6. Chemistry of fats, fatty oils, and soap, MARTIN H. ITTNER.
7. Food chemistry, CARL L. ALSBERG.
8. Chemistry of forest products, JOHN E. TEEPLE.
9. Chemistry of leather and tanning, ALLEN ROGERS.
10. Mineralogical and geological chemistry, FRANK W. CLARKE.
11. Chemistry of paints, varnishes, and resins, HENRY A. GARDNER.
12. Pharmaceutical chemistry, FREDERICK B. POWER.

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VI. DIVISION OF GEOLOGY AND GEOGRAPHY.

JOHN C. MERRIAM, *Chairman.*
WHITMAN CROSS, *Vice Chairman.*

EXECUTIVE COMMITTEE.

ISAIAH BOWMAN.
WHITMAN CROSS.
F. W. DE WOLF.
H. E. GREGORY.
DOUGLAS W. JOHNSON.
LAWRENCE MARTIN.
JOHN C. MERRIAM.
P. S. SMITH.
J. E. SPURR.

COMMITTEES.

1. Geology and paleontology committee, JOHN M. CLARKE, *Chairman.*
2. Geography committee, W. M. DAVIS, *Chairman.*
3. Committee on study of possible contribution of geology and geography to military training, C. P. BERKEY, *Chairman.*
4. Committee on emergency courses of instruction in Geology and geography in educational institutions, HERBERT E. GREGORY, *Chairman.*
5. Committee on special lectures on geologic and geographic subjects at military camps.
6. Committee on quartz resources, G. P. MERRILL, *Chairman.*

VII. DIVISION OF MEDICINE AND RELATED SCIENCES.

R. M. PEARCE, *Chairman.*
PEYTON ROUS, *Vice Chairman.*

EXECUTIVE COMMITTEE.

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H. D. DAKIN.
C. B. DAVENPORT.
W. H. HOWELL.
SIMON FLEXNER.
C. H. MAYO.
W. J. MAYO.
R. M. PEARCE.
PEYTON ROUS.
F. F. RUSSELL.
E. R. STITT.
V. C. VAUGHAN.
W. H. WELCH.
R. M. YERKES.

COMMITTEES.

1. Anatomy committee, C. R. STOCKARD, *Chairman.*
2. Physiology committee, W. B. CANNON, *Chairman;* W. H. HOWELL, *Vice chairman* and *Acting chairman.*
   Subcommittees:
   Fatigue in industrial pursuits, FREDERICK S. LEE, *Chairman.*
   Investigations on the physiology of shock, W. B. CANNON, *Chairman.*
   Control of hemorrhage, W. H. HOWELL, *Chairman.*
3. Committee on medicine and hygiene, VICTOR C. VAUGHAN, *Chairman.*
   Subcommittees:
   Standardization of transfusion methods, PEYTON ROUS, *Chairman.*
   Treatment of chronic anemia, GEORGE H. WHIPPLE, *Chairman.*
4. Committee on neurology and psychiatry, STEWART PAYTON, *Chairman;* E. E. SOUTHARD, *Acting chairman;* S. T. ORTON, *Vice chairman.*

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5. Psychology committee, ROBERT M. YERKES, *Chairman;* JOHN W. BAIRD, *Vice chairman.*
   Subcommittees:
   Problems of aviation, EDWARD L. THORNDIKE, *Chairman.*
   Problems of reeducation, SHEPHERD I. FRANZ, *Chairman.*
   Visual problems, RAYMOND DODGE, *Chairman.*
   Psychological and pedagogical aspects of military training and discipline, WILLIAM C. BAGLEY, *Chairman.*
   Emotional fitness for warfare, R. S. WOODWORTH, *Chairman.*
   Acoustic problems of military importance, C. E. SEASHORE, *Chairman.*
   Adaptation of psychological instruction to military educational needs, RAYMOND DODGE, *Chairman.*
6. Anthropology committees:
   Anthropometry in the Army, CHARLES B. DAVENPORT, *Chairman.*
   Race in relation to disease:
   (1) Military records, A. G. LOVE, *Chairman.*
   (2) Civilian records, F. L. HOFFMAN, *Chairman.*
7. Committees on medical zoology:
   Entomology, L. O. HOWARD, *Chairman.*
   Helminthology, H. B. WARD, *Chairman.*
   Protozoology, C. A. KOFOID, *Chairman.*
8. Committee on biochemistry, F. P. UNDERHILL, *Chairman.*
9. Advisory committee on toxicity of preserved foods, J. J. ABEL, *Chairman.*
10. Committee on industrial poisoning, H. G. WELLS, *Chairman.*

VIII. DIVISION OF AGRICULTURE, BOTANY, FORESTRY, ZOOLOGY, AND FISHERIES.

VERNON KELLOGG, *Chairman.*
A. F. WOODS, *Vice Chairman.*

EXECUTIVE COMMITTEE.

OAKES AMES.
I. W. BAILEY.
E. M. EAST.
KARL KELLERMAN.
VERNON KELLOGG.
B. E. LIVINGSTON.
C. E. MCCLUNG.
H. F. MOORE.
A. F. WOODS.
RAPHAEL ZON.

COMMITTEES.

1. Agriculture, A. F. WOODS, *Chairman.*
2. Botany, JOHN M. COULTER, *Chairman.*
3. Botanical raw products, E. M. EAST, *Chairman.*
4. Zoology, C. E. MCCLUNG, *Chairman.*
5. Fisheries, H. F. MOORE, *Representative.*
6. Forestry, RAPHAEL ZON, I. W. BAILEY, *Representatives.*

SPECIAL COMMITTEES.

1. Fibers, E. M. EAST, *Chairman.*
2. Protein metabolism in animal feeding, H. P. ARMSBY, *Chairman.*
3. Physiological salt requirements of certain cultivated plants, BURTON E. LIVINGSTON, *Chairman.*

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Special joint committee on fertilizer investigations.—A. F. Woods (*Chairman*), E. W. Allen, F. J. Alway, Samuel Avery, Karl Kellerman, J. G. Lipman, Burton E. Livingston, William W. Means.

ORGANIZATION OF THE NATIONAL RESEARCH COUNCIL.

Adopted February 11, 1919, by the Council of the National Academy of Sciences.

PREAMBLE.

The National Academy of Sciences, under the authority conferred upon it by its charter, enacted by Congress, and approved by President Lincoln on March 3, 1863, and pursuant to the request expressed in an Executive Order made by President Wilson on May 11, 1918, hereto appended, adopts the following permanent organization for the National Research Council, to replace the temporary organization under which it has operated heretofore.

ARTICLE I. PURPOSE.

It shall be the purpose of the National Research Council to promote research in the mathematical, physical, and biological sciences, and in the application of these sciences to engineering, agriculture, medicine, and other useful arts, with the object of increasing knowledge, of strengthening the national defense, and of contributing in other ways to the public welfare, as expressed in the Executive Order of May 11, 1918.

ARTICLE II. MEMBERSHIP.

Section 1. The membership of the National Research Council shall be chosen with the view of rendering the Council an effective federation of the principal research agencies in the United States concerned with the fields of science and technology named in Article I.

Section 2. The Council shall consist of—

1. Representatives of national scientific and technical societies;
2. Representatives of the Government, as provided in the Executive Order;
3. Representatives of other research organizations and other persons whose aid may advance the objects of the Council.

ARTICLE III. DIVISIONS.

Section 1. The Council shall be organized in Divisions of two classes: (*a*) Divisions dealing with the more general relations and activities of the Council; (*b*) Divisions dealing with related branches of science and technology.

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Section 2. The initial constitution of the Divisions of the Council shall be as follows:

(*a*) Divisions of General Relations:

I. Government Division.
II. Division of Foreign Relations.
III. Division of States Relations.
IV. Division of Educational Relations.
V. Division of Industrial Relations.
VI. Research Information Service.

(*b*) Divisions of Science and Technology:

VII. Division of Physical Sciences.
VIII. Division of Engineering.
IX. Division of Chemistry and Chemical Technology.
X. Division of Geology and Geography.
XI. Division of Medical Sciences.
XII. Division of Biology and Agriculture.
XIII. Division of Anthropology and Psychology.

Section 3. The number of divisions and the grouping of subjects in Article III, section 2, may be modified by the Executive Board of the National Research Council.

Section 4. The Divisions of General Relations shall be organized by the Executive Board of the National Research Council (Article IV, section 2).

Section 5. To secure the effective federation of the principal research agencies in the United States, provided for in Article II, a majority of the members of each of the Divisions of Science and Technology shall consist of representatives of scientific and technical societies, chosen as provided for in Article V, section 2. The other members of the Division shall be nominated by the Executive Committee of the Division, approved by the Executive Board of the National Research Council, and appointed in accordance with Article V, section 4.

Section 6. The Divisions of the Council, with the approval of the Executive Board, may establish sections and committees, any of which may include members chosen outside the membership of the Council.

ARTICLE IV. ADMINISTRATION.

Section 1. The affairs of each Division shall be administered by a Chairman, a Vice-Chairman, and an Executive Committee, of which the Chairman and the Vice-Chairman shall be ex-officio members; all of whom shall be elected annually by the Division and confirmed by the Executive Board.

Section 2. The affairs of the National Research Council shall be administered by an Executive Board, of which the officers of the

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Council, the President and Home Secretary of the National Academy of Sciences, the President of the American Association for the Advancement of Science, the Chairmen and the Vice-Chairmen of the Divisions of Science and Technology, and the Chairmen of the Divisions of General Relations shall be ex-officio members. The Executive Board may elect additional members, not to exceed ten in number, who, if not already members of the National Research Council, shall be appointed thereto, in accordance with Article V, section 4.

Section 3. The officers of the National Research Council shall consist of a Chairman, one or more Vice-Chairmen, a Secretary and a Treasurer, who shall also serve as members and officers of the Executive Board of the Council.

Section 4. The officers of the National Research Council, excepting the Treasurer, shall be elected annually by the Executive Board. The Treasurer of the National Academy of Sciences shall be ex-officio Treasurer of the National Research Council.

Section 5. The duties of the officers of the Council and of the Divisions shall be fixed by the Executive Board.

ARTICLE V. NOMINATIONS AND APPOINTMENTS.

Section 1. Government bureaus, civil and military, to be represented in the Government Division, and the scientific and technical societies, to be represented in the Divisions of Science and Technology of the National Research Council, shall be determined by joint action of the Council of the National Academy of Sciences and the Executive Board of the National Research Council.

Section 2. Representatives of scientific and technical societies shall be nominated by the societies, at the request of the Executive Board, and appointed by the President of the National Academy of Sciences to membership in the Council and assigned to one of its divisions.

Section 3. The representatives of the Government shall be nominated by the President of the National Academy of Sciences after conference with the Secretaries of the Departments concerned, and the names of those nominated shall be presented to the President of the United States for designation by him for service with the National Research Council.

Section 4. Other members of the Council shall be nominated by the Executive Committees of the Divisions, approved by the Executive Board and appointed by the President of the National Academy of Sciences to membership and assigned to one of the divisions.

Section 5. Prior to the first annual meeting of the Council following January 1, 1919, all Divisions shall be organized by appointment of their members in accordance with Article II and Article V, sections 1 to 4.

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Section 6. As far as practicable, one-third of the original representatives of each scientific and technical society and approximately one-third of the other original members of each of the Divisions of Science and Technology shall serve for a term of three years; one-third for a term of two years, and one-third for a term of one year, their respective terms to be determined by lot. Each year thereafter, as the terms of members expire, their successors shall be appointed for a period of three years.

Section 7. The Government representatives shall serve for periods of three years, unless they previously retire from the Government office which they represent, in which case their successors shall be appointed for the unexpired term.

Section 8. As far as practicable, a similar rotation shall be observed in the appointment of the members of the Divisions of General Relations.

ARTICLE VI. MEETINGS.

Section 1. The Council shall hold one stated meeting, called the annual meeting, in April of each year, in the city of Washington, on a date to be fixed by the Executive Board. Other meetings of the Council shall be held on call of the Executive Board.

Section 2. The Executive Board and each of the Divisions shall hold an annual meeting, at which officers shall be elected, at the time and place of the annual meeting of the Council, unless otherwise determined by the Executive Board and such other meetings as may be required for the transaction of business.

Section 3. Joint meetings of the Executive Board of the National Research Council and the Council of the National Academy of Sciences shall be held from time to time, to consider special requests from the Government, the selection of organizations to be represented in the National Research Council, and other matters which, in the judgment of the President of the National Academy, require the attention of both bodies.

ARTICLE VII. PUBLICATIONS AND REPORTS.

Section 1. An annual report on the work of the National Research Council shall be presented by the Chairman to the National Academy of Sciences, for submission to Congress in connection with the annual report of the President of the Academy.

Section 2. Other publications of the National Research Council may include papers, bulletins, reports, and memoirs, which may appear in the Proceedings or Memoirs of the National Academy of Sciences, in the publications of other societies, in scientific and technical journals, or in a separate series of the Research Council.

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ANNUAL REPORT OF THE TREASURER.

JANUARY 1 TO DECEMBER 31, 1918.

To the PRESIDENT OF THE NATIONAL ACADEMY OF SCIENCES:

I have the honor to submit the following report as treasurer for the fiscal year January 1 to December 31, 1918. Some of the items of general interest will be mentioned before presenting details.

The volume of financial transactions, apart from investments, is indicated by the statement that the income of the academy from dues, interest on investments, subscriptions to the Proceedings, contributions to Proceedings fund, and the William Ellery Hale lectureship was $15,912.86, while the miscellaneous disbursements amounted to $9,596.74, and payments on grants from trust funds and for medals were $3,600.66.

The sum of investments held by the academy on December 31 was $257,761, yielding on that date at the rate of 5.27 per cent.

Changes in investments may be summarized as follows: Loans on real estate aggregating $7,250 were paid, and loans amounting to $16,000 were renewed at increased rates of interest; one new note was purchased at $1,500. Bonds of the face value of $21,200 were purchased for $19,727.50.

In accordance with the action of the academy in November, 1916, the capital of the Marsh fund was increased to $19,000 through the addition to it of interest on the deferred payments of the bequest from Prof. O. C. Marsh, received in 1916, and by transfer of accumulated income. By the addition of further increments of $500 annually from income this fund will, on February 1, 1920, reach the total of $20,000 authorized by the academy.

A further payment of $2,500 was received from the executors of the estate of Mrs. Mary Anna Palmer Draper toward the total of $25,000 bequeathed to the academy by Mrs. Draper in 1915 to establish the Billings fund.

The sum of $3,000 was added to the Bache fund from accumulated income on February 1, 1918, in accordance with the directions of the directors.

The sum of $23,856.82 was received toward defraying expenses of the division of medicine and related sciences of the National Research Council from a total appropriation of $50,000 from the Rockefeller

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Foundation, and $15,955.35 was expended for that purpose. This fund was handled through a special bank account.

The consolidated investment fund reached a total of $181,895.50 by the additions during the year to the Bache and Billings funds.

Through Maj. W. W. Keen, M. C., of Philadelphia, a contribution was made to the National Research Council of $483.96 for the use of the division of medicine and related sciences, from the royalties on a book which he had published, entitled "Treatment of War Wounds."

TRUST FUNDS OF THE ACADEMY.

The trust funds of the academy, the income of which is administered for specific purposes, are enumerated below. The capital of certain funds has been increased beyond the amount of the original gift or bequest, by the transfer of accumulated income, at the request of the donors or by action of the academy.

Bache fund: Bequest of Alexander Dallas Bache, a member of the academy, 1870. To aid researches in physical and natural sciences	$50,000.00
Watson fund: Bequest of James C. Watson, a member of the academy, 1874. For the promotion of astronomical science through the award of the Watson gold medal and grants of money in aid of research	25,000.00
Draper fund: Gift of Mrs. Henry Draper, 1883. In memory of her husband, a former member of the academy. To found the Henry Draper gold medal, to be awarded for notable investigations in astronomical physics. The balance of income is applied to aid research in the same science	10,000.00
Smith fund: Gift of Mrs. J. Lawrence Smith, 1884, in memory of her husband, a former member of the academy. To found the J. Lawrence Smith gold medal, to be awarded for important investigations of meteoric bodies and to assist, by grants of money, researches concerning such objects	10,000.00
Gibbs fund: Established by gift of Wolcott Gibbs, a member of the academy, 1892, and increased by a bequest of the late Morris Loeb, 1914. For the promotion of researches in chemistry	5,545.50
Gould fund: Gift of Miss Alice Bache Gould, 1897, in memory of her father, a former member of the academy. For the promotion of researches in astronomy	20,000.00
Comstock fund: Gift of Gen. Cyrus B. Comstock, a member of the academy, 1907. To promote researches in electricity, magnetism, or radiant energy, through the Comstock prize, of money, to be awarded once in five years for notable investigations. The fund is to be increased ultimately to $15,000	12,406.02
Marsh fund: Bequest of Othniel Charles Marsh, a member of the academy, 1909. To promote original research in the natural sciences. To the original bequest of $10,000 the academy has added interest received from the estate and authorized the increase of the fund to $20,000 by annual additions from income	19,000.00

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Murray fund: A gift from Sir John Murray, 1911, to found the Alexander Agassiz gold medal, in honor of a former member and president of the academy, to be awarded for original contributions to the science of oceanography $6,000.00

Hartley fund: A gift from Mrs. Helen Hartley Jenkins, 1913–14, in memory of her father, Marcellus Hartley, to found the medal of the academy awarded for eminence in the application of science to the public welfare 1,200.00

Billings fund: Established by the bequest of Mrs. Mary Anna Palmer Draper (Mrs. Henry Draper) of $25,000, 1915. To support the publication of the Proceedings of the academy or for other purpose to be determined by the academy. Three installments 5,000.00

Elliot fund: Gift of Margaret Henderson Elliot to found the Daniel Giraud Elliot gold medal and honorarium, for the most meritorious work in zoology or palaeontology published in each year 8,000.00

In addition to the above-named funds the academy holds the following:

Agassiz fund: Bequest of Alexander Agassiz, a member of the academy, 1910, for the general uses of the academy $50,000.00

Building fund: A gift from Alexander Agassiz and Theodore N. Gill, former members of the academy, toward a building for the academy, together with accumulated income 9,400.00

STATEMENTS OF ASSETS AND LIABILITIES, DECEMBER 31, 1918.

ASSETS.

1. Mortgage notes, secured by first mortgages on real estate		$80,000.00
2. Bonds, giving name, face value, rate of interest, and cost:		
5 American Telephone & Telegraph Co. 30-year, 5 per cent, gold collateral trust 5's, due Dec. 1, 1946. 5 at $1,000. Nos. 640, 4604, 29245, 29246, 41419	$4,752.50	
5 Asheville Power & Light Co., first mortgage 30-year gold, 5 per cent, due Apr. 1, 1942, New York. 5 at $1,000. Nos. 272, 490, 492, 508, 509	4,892.50	
12 Broadway Realty Co., purchase money, first 5 per cent gold, due Sept. 1, 1926. 12 at $1,000. Nos. 38, 50, 796, 963–5, 1068, 1616–20	12,345.00	
10 Bush Terminal Buildings Co., first mortgage 50-year sinking fund, 5 per cent gold, due Apr. 1960. 10 at $1,000. Nos. 1383–1387 and 2805–2809	9,375.00	
5 Chesapeake & Ohio, general mortgage, 4.5's gold, due New York, Mar. 1, 1992. 5 at $1,000. Nos. 15350, 15351, 15352, 15353, 15354	4,600.00	
4 City of Tacoma, Green River special water fund No. 2. 5 per cent, due Oct. 1, 1939. 4 at $1,000. Nos. 1508, 1509, 1510, 1511	4,140.00	
12 Cleveland Electric & Illuminating Co., first mortgage, 5 per cent gold, due New York, Apr. 1, 1939. 4 at $500 and 8 at $1,000. Nos. M6060, M6096, M6097, M15094–15098, D261–264	9,597.50	

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2. Bonds, etc.—Continued.

18	Cosmos Club, 4.5 per cent, due July 1, 1949. 18 at $1,000. Nos. 286–7–8–9, 290–1–2–3–4, 296–7, 299, 301–2–3–4–5, 350	$18,000.00
9	Detroit Edison Co., 5's, first mortgage, 30-year, gold, due Jan. 1, 1933. 10 at $1,000. Nos. 557, 2442, 2443, 3024, 3252, 3253, 3639–3641, 8086	10,072.50
6	Detroit Edison Co., first and refunding mortgage, gold, 5's, due Jan. 1, 1940. 4 at $1,000; 3 at $500. Nos. 9657–8–9–60, D501, D502, D599	5,005.00
4	Dominion Coal Co. (Ltd.), first mortgage, sinking-fund gold, 5 per cent, due New York, May 1, 1940. 4 at $1,000. Nos. A1037–A1040	4,675.00
8	Galveston, Harrisburg & San Antonio, Mexican & Pacific Ex., 6 per cent second guaranteed reduced to 5 per cent due Jan. 1, 1931. 8 at $1,000. Nos. 1044, 1048, 1248, 2112–2116	8,030.00
2	Georgia Ry. & Electric Co., first consolidated mortgage, 5's, sinking-fund gold, due Jan. 1, 1932. 2 at $1,000. Nos. 1061, 1600	2,055.00
13	Government of the Province of Alberta 4.5 per cent, 10-year gold debenture, due New York, Dec. 1, 1923. 11 at $100, Nos. 1501–1511; 2 at $500, Nos. 2031, 2032, $2,100	2,008.50
6	Government of the Province of Alberta, 5 per cent, 10-year gold debenture, due New York, May 1, 1925. 1 at $1,000, No. 2364; 5 at $500, Nos. 0189B–0193B; $3,500	3,373.75
1	Government of the Province of Alberta, 4.5 per cent, 10-year gold debenture, due New York, Feb. 1, 1924, 1 at $500. No. 2620	480.00
4	Grand Rapids Gas Light Co., 5 per cent, first mortgage, gold, due New York, Aug. 1, 1939. 4 at $1,000. Nos. A522, A523, A595, A596	4,020.00
1	Hydraulic Power Co. of Niagara Falls, 5 per cent refunding and improvement mortgage, due Oct. 1, 1951. 2 at $500. Nos. D457, D458	890.00
35	Liberty, third loan, 4¼ per cent gold of 1928. 25 at $100. Nos. 1,049.788 to 1,049,800, 1,050,701 to 1,050,712; 10 at $50. Nos. 1,886,579 to 1,886,588	3,000.00
2	Liberty, fourth loan, 4¼ per cent gold of 1933–1938. 2 at $100. Nos. 2,566,501–2	200.00
9	Milwaukee Electric Railway & Light Co., 5 per cent general and refunding mortgage gold, series A, due New York, Dec. 1, 1951. 9 at $1.000. Nos. 2088, 2772, 3830, 3840, 3930, 3931, 5222, 5223, 5224	8,237.50
10	Minneapolis General Electric Co., 5 per cent, 30-year gold-mortgage, due New York, Dec. 1, 1934. 10 at $1,000. Nos. 1621, 1622, 1949, 2004, 2572, 2573, 2574, 2575, 7579, 7580	9,880.00

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2. Bonds, etc.—Continued.		
4 Niagara Falls Power Co., first mortgage 5's, gold coupon, due Jan. 1, 1932. 4 at $1,000. Nos. 5246, 5247, 6583, 8358	$4,100.00	
14 Riggs Realty Co., 3/30-year coupon, first 5's due Washington, D. C., Oct. 1, 1940. 14 at $1,000. Nos. 92, 96, 100, 104, 108, 112, 116, 120, 124, 128, 132, 136, 140, 144	14,532.50	
10 Shawinigan Water & Power Co., 5 per cent consol. mortgage 30-year, gold, due Jan. 1, 1934. 4 at $1,000. Nos. M0354, M0510, M2894, M2943; 2 at $500. Nos. D4647, D5337	4,752.50	
9 Southern Bell Telephone & Telegraph Co., 30-year first mortgage, 5's, sinking fund, gold, due Jan. 1, 1941. 9 at $1,000. Nos. M9739, M11576, M11577, M11578, M11579, M13965, M15568, M15569, M15570	8,942.50	
3 Union Electric Light & Power Co. of St. Louis, 5 per cent first mortgage, 30-year, gold, due New York, Sept. 1, 1932. 3 at $1,000. Nos. 1352, 4169, 8601	2,862.50	
5 Vicksburg, Shreveport & Pacific R. R. Co., prior lien mortgage, at 6 per cent gold, renewed at 5 per cent due Nov. 1, 1915; extended to Nov. 1, 1940. 5 at $1,000. Nos. 561, 661, 794, 982, 1323	5,050.00	
8 Virginian Ry. Co., first mortgage, 50-year gold 5 per cent due New York, Nov. 1, 1962. 8 at $1,000. Nos. M4290, M4291, M14151, M23372, M23821, M23822, M23823, M23824	7,891.25	
		$177,761.00
3. Bank balance, Dec. 31, 1918		14,187.34
		271,948.34

LIABILITIES.

	Income.	Capital.
General fund:		
Invested	$4,176.25	----------
Uninvested	508.81	----------
Agassiz fund:		
Invested	----------	$50,000.00
Uninvested	----------	----------
Bache fund:		
Invested	500.00	59,000.00
Uninvested	2,223.98	----------
Billings fund:		
Invested	50.00	3,750.00
Uninvested	97.66	1,250.00
Building fund:		
Invested	200.00	9,400.00
Uninvested	199.63	----------
Comstock fund:		
Invested	----------	12,368.75
Uninvested	646.04	37.27
Consolidated fund:		
Invested	----------	----------
Uninvested	1,575.33	----------

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	Income.	Capital.
Draper fund:		
Invested	$1,952.50	$10,000.00
Uninvested	449.30	
Elliot fund:		
Invested	300.00	8,000.00
Uninvested	182.57	
Gibbs fund:		
Invested	500.00	5,545.50
Uninvested	44.33	
Gould fund:		
Invested	5,255.00	19,992.50
Uninvested	1,315.96	7.50
Hale lectureship:		
Invested	200.00	
Uninvested	23.34	
Hartley fund:		
Invested		1,200.00
Uninvested	76.77	
Marsh fund:		
Invested	150.00	19,000.00
Uninvested	857.00	
Murray fund:		
Invested	400.00	6,000.00
Uninvested	432.05	
National Research Council:		
Invested	1,865.00	
Uninvested	1,059.84	
Proceedings:		
Invested		
Uninvested	1,247.35	
Smith fund:		
Invested	2,032.50	10,000.00
Uninvested	683.95	
Watson fund:		
Invested	1,103.75	24,996.25
Uninvested	1,087.91	3.75
	31,396.82	240,551.52
		31,396.82
		271,948.34
Consolidated investment fund:		
Invested		181,718.50
Uninvested	1,575.33	177.00

CONDENSED STATEMENT OF RECEIPTS AND EXPENDITURES, 1918.

RECEIPTS.

Balance, Jan. 1, 1918, as per last report		$16,865.30
Cash receipts:		
Total income from investments	[1] $12,209.24	
Bonds called in and paid	7,250.00	
Mortgage notes paid	5,040.00	

[1] Interest to the amount of $750 (1917) and $750 (1918); total, $1,500 due from an unsettled estate.

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Cash receipts—Continued.		
Annual dues	$810.00	
Interest on bank deposits	243.76	
Wm. Ellery Hale lectureship	300.00	
Billings fund from Draper estate	2,500.00	
Contributions to Proceedings	575.00	
Subscriptions to Proceedings	1,430.74	
Reprints and separate numbers of Proceedings	344.42	
Contribution of W. W. Keen to National Research Council	483.96	
Rockefeller Foundation	10,000.00	
Return of grant to Holmes from Gibbs fund	86.32	
		$41,273.44
Book transfers:		
Income transfers	1,325.00	
Capital transfers	2,575.00	
Comstock transfer	677.50	
General fund transfer	510.00	
Distribution of income from consolidated	7,707.14	
		12,794.64
		70,938.38

EXPENDITURES.

Cash expenditures:		
Investment of capital	$21,427.50	
Accrued interest	245.62	
Dominion Coal	125.00	
		$21,798.12
Book transfers:		
Income transfers	1,325.00	
Capital transfers	2,575.00	
Comstock transfer	677.50	
General fund transfer	510.00	
Distribution of income from consolidated	7,707.14	
		12,794.64
Payments from trust and other funds:		
Bache fund—		
F. A. Shull	485.00	
J. Voûte	211.86	
Comstock fund—		
Samuel Jackson Barnett, prize and diploma	1,525.00	
Draper fund—		
Joel Stebbins	300.00	
Walter S. Adams, medal	212.80	
Elliot fund—		
F. M. Chapman, medal and honorarium	181.00 200.00	
Gould fund—		
Astronomical Journal	500.00	
Hale lectureship—		
Honorarium	300.00	
Marsh fund—		
Printing	9.75	

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Payments from trust and other funds—Continued.		
Smith fund—		
G. P. Merrill	$85.00	
S. A. Mitchell	300.00	
Watson fund—		
H. C. Wilson	300.00	
John A. Miller	500.00	
		$5,110.41
Rockefeller Foundation:		
S. A. Hanna, to Special Account	55.00	
Transfer	9,945.00	
		10,000.00
Proceedings:		
Salary, managing editor	750.00	
Printing and distributing	2,577.92	
Expenses, Boston office	265.50	
Expenses, Washington office	237.59	
		3,831.01
General fund:		
Salary, assistant secretary and treasurer	600.00	
Treasurer's office	175.00	
Home secretary's office	594.05	
Memoirs, printing, etc	1,064.61	
Meeting—		
Annual	612.60	
Autumn	137.21	
Election of members	28.38	
		3,211.86
		56,746.04
Balance Dec. 31, 1918		14,187.34
		70,933.38

ACCOUNTS WITH INDIVIDUAL FUNDS JAN. 1 TO DEC. 31, 1918.

	General fund.		Agassiz fund.	
	Income.	Capital.	Income.	Capital.
Balance Jan. 1, 1918:				
Cash	$802.99			
Invested	4,686.25			$50,000.00
Receipts:				
Interest on deposits	243.76			
Interests on investments	2,359.85			
	7,892.85			50,000.00
Disbursements:				
General expenses	3,207.79			
Balance Dec. 31, 1918:				
Cash	508.81			
Invested	4,176.25			50,000.00
	7,892.85			50,000.00

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Accounts with individual funds, Jan. 1 to Dec. 31, 1918—Continued.

	Bache fund.		Billings fund.	
	Income.	Capital.	Income.	Capital.
Balance Jan. 1, 1918:				
Cash	$1,249.76			
Invested	2,575.00	$56,000.00		$2,500.00
Receipts:				
Interest on investments	2,596.08		$147.66	
Transfer, income to capital		3,000.00		
From Draper estate			1,250.00	1,250.00
	6,420.84	59,000.00	1,397.66	3,750.00
Disbursements:				
Grants	685.00			
J. Voûte, expense of cable	11.86			
Transfer, income to capital	3,000.00			
Balance Dec. 31, 1918:				
Cash	2,223.98		1,347.66	
Invested	500.00	59,000.00	50.00	3,750.00
	6,420.84	59,000.00	1,397.66	3,750.00

	Building fund.		Comstock fund.	
	Income.	Capital.	Income.	Capital.
Balance Jan. 1, 1918:				
Cash	$399.29		$854.25	$87.27
Invested		$9,000.00	677.50	12,318.75
Receipts:				
Interest on investments	400.33		1,316.79	
Transfer income to capital		400.00		
	799.62	9,400.00	2,848.54	12,406.02
Disbursements:				
General expenses			26.00	
Transfer income to capital	400.00			
Transfer cash from investment			677.50	
Prizes			1,500.00	
Balance Dec. 31, 1918:				
Cash	199.63		646.04	37.27
Invested	200.00	9,400.00		12,368.75
	799.62	9,400.00	2,848.54	12,406.02

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Accounts with individual funds, Jan. 1 to Dec. 31, 1918—Continued.

	Consolidated fund.		Draper fund.	
	Income.	Capital.	Income.	Capital.
Balance Jan. 1, 1918:				
Cash	$1,097.53	$1,674.50	$534.89	
Invested		175,071.00	1,952.50	$10,000.00
Receipts:				
Interest on investment	8,532.09		427.21	
Cash transfer		2,575.00		
Investment transfer		2,575.00		
	9,629.62	181,895.50	2,914.60	10,000.00
Disbursements:				
Grants and medals			512.80	
Distribution of income to funds	7,707.14			
Accrued interest	347.15			
Balance Dec. 31, 1918:				
Cash	1,575.33	177.00	449.30	
Invested		181,718.50	1,952.50	10,000.00
	9,629.62	181,895.50	2,914.60	10,000.00

	Elliot fund.		Gibbs fund.	
	Income.	Capital.	Income.	Capital.
Balance Jan. 1, 1918:				
Cash	$517.22		$261.33	
Invested		$8,000.00		$5,545.50
Receipts:				
Interest on investments	346.35		283.00	
	863.57	8,000.00	544.33	5,545.50
Disbursements:				
General expenses				
Medals and honorariums	381.00			
Balance Dec. 31, 1918:				
Cash	182.57		44.33	
Invested	300.00	8,000.00	500.00	5,545.50
	863.57	8,000.00	544.33	5,545.50

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Accounts with individual funds, Jan. 1 to Dec. 31, 1918—Continued.

	Gould fund.		Hale lectureship.	
	Income.	Capital.	Income.	Capital.
Balance Jan. 1, 1918:				
Cash	$1,642.67	$57.50	$220.28	
Invested	4,067.50	19,942.50		
Receipts:				
Interest on investments	1,360.79		3.06	
Contribution to Hale lectureship			300.00	
	7,070.96	20,000.00	523.34	
Disbursements:				
Grants of medals	500.00			
Honorarium			300.00	
Balance Dec. 31, 1918:				
Cash	1,315.96	7.50	23.34	
Invested	5,255.00	19,992.50	200.00	
	7,070.96	20,000.00	523.34	

	Hartley fund.		Marsh fund.	
	Income.	Capital.	Income.	Capital.
Balance Jan. 1, 1918:				
Cash	$25.51		$716.81	
Invested		$1,200.00		$18,500.00
Receipts:				
Interest on investments	51.26		799.94	
Transfer capital from income				500.00
	76.77	1,200.00	1,516.75	19,000.00
Disbursements:				
General expenses			9.75	
Transfer income to capital			500.00	
Balance Dec. 31, 1918:				
Cash	76.77		857.00	
Invested		1,200.00	150.00	19,000.00
	76.77	1,200.00	1,516.75	19,000.00

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Accounts with individual funds, Jan. 1 to Dec. 31, 1918—Continued.

	Murray fund.		Proceedings fund.	
	Income.	Capital.	Income.	Capital.
Balance Jan. 1, 1918:				
Cash	$569.61		$1,922.27	
Invested		$6,000.00		
Receipts:				
Interest on investments	262.44			
Annual dues			810.00	
Subscriptions			1,481.84	
Reprints			343.32	
Contributions			575.00	
	832.05	6 000.00	5,082.43	
Disbursements:				
Managing editor			750.00	
Boston office			269.57	
Washington office			237.59	
Printing			2,577.92	
Balance Dec. 31, 1918:				
Cash	432.05		1,247.35	
Invested	400.00	6,000.00		
	832.05	6,000.00	5,082.43	

	National Research Council		National Research Council special.	
	Income.	Capital.	Income.	Capital
Balance Jan. 1, 1918:				
Cash	$2,389.35			
Invested				
Receipts:				
Interest on investments	75.00		$114.25	
W. W. Kean contribution	483.96			
Rockefeller Foundation			23,856.82	
Jewell D. Emery refund			20.54	
	2,948.31		23,991.61	
Disbursements:				
Accrued interest	23.47		15,975.89	
Balance Dec. 31, 1918:				
Cash	1,059.84		8,015.72	
Invested	1,865.00			
	2,948.31		23,991.61	

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Accounts with individual funds, Jan. 1 to Dec. 31, 1918—Continued.

	Smith fund.		Watson fund.	
	Income.	Capital.	Income.	Capital.
Balance Jan. 1, 1918:				
Cash	$1,084.20		$799.32	$203.75
Invested	1,532.50	$10,000.00	1,003.75	24,796.25
Receipts:				
Interest on investments	484.75		1,188.59	
	3,101.45	10,000.00	2,991.66	25,000.00
Disbursements:				
Grants awarded	385.00		900.00	
Balance Dec. 31, 1918:				
Cash	683.95		1,087.91	3.75
Invested	2,032.50	10,000.00	1,103.75	24,996.25
	3,101.45	10,000.00	2,991.66	25,000.00

WHITMAN CROSS,
Treasurer.

January 15, 1919.

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REPORT OF THE AUDITING COMMITTEE.

WASHINGTON, D. C., *January 15, 1919.*

We have employed the Capital Audit Co. to scrutinize and report on the treasurer's books. We accepted the certification, dated January 13, 1919, of the American Security & Trust Co. regarding notes on deposit owned by the academy, and we have examined the securities and papers contained in the box of the National Academy of Sciences at the vault of the American Security & Trust Co. We find them to correspond to the list checked by the auditing committee on January 14, 1918, except as modified by transactions of the year 1918 reported by the Capital Audit Co. We find that the coupons due in 1918 have been cut and are accounted for, and those due January 1, 1919, are detached and are accounted for by appropriate entries in the pass books. We find that interest on loans has been accounted for, except the interest on the Upshur note, which has been retained by litigation. Correspondence between vouchers, pass books, and accounts of the treasurer is certified by the Capital Audit Co. We find the balance reported by the treasurer as of December 31, 1918, to accord with the statement of the American Security & Trust Co. and with the check book, except for certain outstanding checks to the amount of $328.27 listed by the Capital Audit Co.

In addition to the regular financial statement of the treasurer, there is a special account in support of the division of medicine of the National Research Council. This account has been included in the report of the Capital Audit Co. We find that the treasurer's balance as of December 31, 1918, agrees with the statement of the American Security & Trust Co. for this special account.

C. G. ABBOT.
L. O. HOWARD.
DAVID WHITE.

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APPENDIXES.

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APPENDIX A.

CONSTITUTION OF THE NATIONAL ACADEMY.

As amended and adopted April 17, 1872, and further amended April 20, 1875; April 21, 1881; April 19, 1882; April 18, 1883; April 19, 1888; April 18, 1895; April 20, 1899; April 17, 1902; April 18, 1906; November 20, 1906; April 17, 1907; November 20, 1907; April 20, 1911; April 16, 1912; April 21, 1915.

PREAMBLE.

Empowered by the act of incorporation enacted by Congress, and approved by the President of the United States on the 3d day of March, A. D. 1863, and in conformity with amendments to said act approved July 14, 1870, June 20, 1884, and May 27, 1914, the National Academy of Sciences adopts the following amended constitution and rules:

ARTICLE I.—OF MEMBERS.

SECTION 1. The academy shall consist of members, honorary members, and foreign associates. Members must be citizens of the United States.

SEC. 2. Members who, from age or inability to attend the meetings of the academy, wish to resign the duties of active membership, may, at their own request, be transferred to the roll of honorary members by a vote of the academy.

SEC. 3. The academy may elect 50 foreign associates.

SEC. 4. Honorary members and foreign associates shall have the privilege of attending the meetings and of reading and communicating papers to the academy, but shall take no part in its business, shall not be subject to its assessments, and shall be entitled to a copy of the publications of the academy.

ARTICLE II.—OF THE OFFICERS.

SECTION 1. The officers of the academy shall be a president, a vice president, a foreign secretary, a home secretary, and a treasurer, all of whom shall be elected for a term of four years, by a majority of votes present, at the first stated meeting after the expiration of the current terms, provided that existing officers retain their places until their successors are elected. In case of a vacancy, the election for

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four years shall be held in the same manner at the meeting when such vacancy occurs, or at the next stated meeting thereafter, as the academy may direct. A vacancy in the office of treasurer or home secretary may, however, be filled by appointment of the president of the academy until the next stated meeting of the academy.

SEC. 2. The officers of the academy, together with six members to be elected by the academy, shall constitute a council for the transaction of such business as may be assigned to them by the constitution or the academy.

SEC. 3. The president of the academy, or, in case of his absence or inability to act, the vice president, shall preside at the meetings of the academy and of the council; shall name all committees except such as are otherwise especially provided for; shall refer investigations required by the Government of the United States to members especially conversant with the subjects and report thereon to the academy at its meeting next ensuing; and, with the council, shall direct the general business of the academy.

It shall be competent for the president, in special cases, to call in the aid, upon committees, of experts or men of special attainments not members of the academy.

The president shall be, ex officio, a member of all committees empowered to consider questions referred to the academy by the Government of the United States.

SEC. 4. The foreign and home secretaries shall conduct the correspondence proper to their respective departments, advising with the president and council in cases of doubt, and reporting their action to the academy at one of the stated meetings in each year.

It shall be the duty of the home secretary to give notice to the members of the place and time of all meetings, of all nominations for membership, and of all proposed amendments to the constitution.

It shall be the duty of the home secretary to keep the minutes of each business and scientific session, and after approval to enter these upon the permanent records of the academy.

SEC. 5. The treasurer shall attend to all receipts and disbursements of the academy, giving such bond and furnishing such vouchers as the council may require. He shall collect all dues, assessments, and subscriptions, and keep a set of books showing a full account of receipts and disbursements and the condition of all funds of the academy. He shall be the custodian of the corporate seal of the academy.

ARTICLE III.—OF THE MEETINGS.

SECTION 1. That the academy shall hold one stated meeting, called the annual meeting, in April of each year in the city of Washington, and another stated meeting, called the autumn meeting, at a place

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to be determined by the council. The council shall also have power to fix the date of each meeting.

Special business meetings of the academy may be called, by order of eight members of the council, at such place and time as may be designated in the call.

Special scientific meetings of the academy may be held at times and places to be designated by a majority of the council.

SEC. 2. The names of the members present at each session of a meeting shall be recorded in the minutes, and the members present at any session shall constitute a quorum for the transaction of business.

SEC. 3. Scientific sessions of the academy, unless otherwise ordered by a majority of the members present, shall be open to the public; sessions for the transaction of business shall be closed.

SEC. 4. Stated meetings of the council shall be held during the stated or special meetings of the academy and four members shall constitute a quorum for the transaction of business. Special meetings of the council may be convened at the call of the president and two members of the council, or of four members of the council.

SEC. 5. No member whose dues are in arrears shall vote at any business meeting of the academy.

ARTICLE IV.—OF ELECTIONS AND RESIGNATIONS.

SECTION 1. All elections of officers and members shall be by ballot, and each election shall be held separately.

SEC. 2. The time for holding an election of officers shall be fixed by the academy at least one day before the election is held.

SEC. 3. The election of the six members of the council shall be as follows:

At the annual meeting in April, 1907, six members of the council to be elected, of whom two shall serve for three years, two for two years, and two for one year, their respective terms to be determined by lot. Each year thereafter the terms of two members shall expire, and their successors, to serve for three years, shall be elected at the annual meeting in each year.

SEC. 4. The academy shall be divided by the council into sections representing the principal branches of scientific research. Each section shall elect its own chairman, who shall serve for three years. The chairman shall be responsible to the academy for the work of his section.

Nominations to membership in the academy shall be made in writing and approved by a majority of the members of the section on the branch of research in which the person nominated is eminent, or by a majority of the council in case there is no section on the subject.

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The nomination shall be sent to the home secretary by the chairman of the section before January 1 of the year in which the election is to be held, and each nomination shall be accompanied by a list of the principal contributions of the nominee to science. This list shall be printed by the home secretary for distribution among the members of the academy.

SEC. 5. Election of members shall be held at the annual meeting in Washington in the following manner: There shall be two ballots—a preference ballot, which may be prepared either before or at the annual meeting, and must be transmitted to the home secretary, and a final ballot, to be taken at the meeting.

Preference ballot.—Each member may inscribe on a ballot not more than 15 names of nominees selected from the submitted list. A list of the nominees shall then be prepared, on which the names shall be entered in the order of the number of votes received by each. In case two or more nominees have the same number of votes on this preference list, the order in which they shall be placed on the list shall be determined by a majority vote of members present.

Final ballot.—A vote shall first be taken on the nominee who appears first on the preference list, and he shall be declared elected if he receive two-thirds of the votes cast and not less than 25 votes in all. A vote shall then be taken in similar manner on the nominee standing second on the preference list, and so on until all the nominees on the preference list shall have been acted on, or until 15 nominees shall have been elected, or until the total membership of the academy shall have reached 250.

Not more than 15 members shall be elected at one annual meeting.

Before and during elections a discussion of the merits of nominees will be in order.

SEC. 6. Every member-elect shall accept his membership, personally or in writing, before the close of the next stated meeting after the date of his election. Otherwise, on proof that the secretary has formally notified him of his election, his name shall not be entered on the roll of members.

SEC. 7. Foreign associates may be nominated by the council and may be elected at the annual meeting by a two-thirds vote of the members present.

SEC. 8. A diploma, with the corporate seal of the academy and the signatures of the officers, shall be sent by the appropriate secretary to each member on his acceptance of membership, and to foreign associates on their election.

SEC. 9. Resignations shall be addressed to the president and acted on by the academy.

SEC. 10. Whenever a member has not paid his dues for four successive years, the treasurer shall report the fact to the council, which

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may report the case to the academy with the recommendation that the person thus in arrears be declared to have forfeited his membership. If this recommendation be approved by two-thirds of the members present, the said person shall no longer be a member of the academy and his name shall be dropped from the roll.

ARTICLE V.—SCIENTIFIC COMMUNICATIONS, PUBLICATIONS, AND REPORTS.

SECTION 1. Communications on scientific subjects shall be read at scientific sessions of the academy, and papers by any member may be read by the author or by any other member, notice of the same having been previously given to the secretary.

SEC. 2. Any member of the academy may read a paper from a person who is not a member, and shall not be considered responsible for the facts or opinions expressed by the author, but shall be held responsible for the propriety of the paper.

Persons who are not members may read papers on invitation of the council or of the committee of arrangements.

SEC. 3. The academy may provide for the publication, under the direction of the council, of proceedings, scientific memoirs, biographical memoirs, and reports.

The proceedings shall include the transactions of the academy, brief original announcements of the results of scientific investigations made by members of the academy or others, together with short original articles giving a comprehensive survey of the more important scientific researches currently made by American investigators, and other matters of general scientific interest.

The scientific memoirs shall provide opportunity for the publication of longer and more detailed scientific investigations.

The biographical memoirs shall contain an appropriate record of the life and work of deceased members of the academy.

An annual report shall be presented to Congress by the president and shall contain the annual reports of the treasurer and the auditing committee, a suitable summary of the reports of the committees in charge of trust funds, and a record of the activities of the academy for the calendar year immediately preceding, and other appropriate matter. This report shall be presented to Congress by the president after authorization by the council. It shall also be presented to the academy at the annual meeting next following.

The treasurer shall prepare a full report of the financial affairs of the academy at the end of the fiscal year. This report shall be submitted to the council for approval and afterwards presented to the academy at the annual meeting.

SEC. 4. Propositions for investigations or reports by the academy shall be submitted to the council for approval, except those requested

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by the Government of the United States, which shall be acted on by the president, who will in such cases report their results to the Government as soon as obtained and to the academy at its next following stated meeting.

SEC. 5. The advice of the academy shall be at all times at the disposition of the Government upon any matter of science or art within its scope.

ARTICLE VI.—OF THE PROPERTY OF THE ACADEMY.

SECTION 1. All investments and reinvestments of either principal or accumulations of income of the trust and other funds of the academy shall be made by the treasurer, with the approval of the finance committee, in the corporate name of the academy, in the manner and in the securities designated or specified in the instruments creating the several funds, or, in the absence of such designation or specification, in bonds of the United States or of the several States, or in bonds or notes secured by first mortgages on real estate, in investments legal for savings banks under the laws of Massachusetts or New York, or in other bonds recommended to the treasurer by the fiscal advisers of the academy.

The treasurer may invest the capital of all trust funds of the academy which are not required by the instruments creating such funds to be kept separate and distinct, in a consolidated fund, and shall apportion the income received from such consolidated fund among the various funds composing the same in the proportion that each of said funds shall bear to the total amount of funds so invested; provided, however, that the treasurer shall at all times keep accurate accounts showing the amount of each trust fund, the proportion of the income from the consolidated fund to which it is entitled, and the expenses and disbursements properly chargeable to such fund.

SEC. 2. The council shall at its annual meeting in each year designate one bank or trust company in Washington, D. C., and one in New York City to act, when requested by the treasurer, as the fiscal advisers of the academy.

SEC. 3. The treasurer shall have authority, with the approval of the finance committee, to sell, transfer, convey, and deliver in the corporate name and for the benefit of the academy any stocks, bonds, or other securities standing in the corporate name.

SEC. 4. No contract shall be binding upon the academy which has not been first approved by the council.

SEC. 5. The assessments required for the support of the academy shall be fixed by the academy on the recommendation of the council and shall be payable within the calendar year for which they are assessed.

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ARTICLE VII.—OF TRUST FUNDS AND THEIR ADMINISTRATION.

SECTION 1. Devises, bequests, donations, or gifts having for their object the promotion of science or the welfare of the academy may be accepted by the council for the academy. Before the acceptance of any such trust the council shall consider the object of the trust and all conditions or specifications attaching thereto. The council shall make a report of its action to the academy.

SEC. 2. Medals and prizes may be established in accordance with the provisions of trusts or by action of the academy.

SEC. 3. Unless otherwise provided by the deed of gift, the income of each trust fund shall be applied to the objects of that trust by the action of the academy on the recommendation of a standing committee on that fund.

ARTICLE VIII.—OF ADDITIONS AND AMENDMENTS.

Additions and amendments to the constitution shall be made only at a stated meeting of the academy. Notice of a proposition for such a change must be submitted to the council, which may amend the proposition, and shall report thereon to the academy. Its report shall be considered by the academy in committee of the whole for amendment.

The proposition as amended, if adopted in committee of the whole, shall be voted on at the next stated meeting, and if it receives two-thirds of the votes cast it shall be declared adopted.

Absent members may send their votes on pending changes in the constitution to the home secretary in writing, and such votes shall be counted as if the members were present.

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APPENDIX B.

RULES.

(In accordance with a resolution of the academy, taken at its meeting on April 21, 1915, the rules are arranged in groups and each group is numbered to correspond with the article of the constitution to which it relates.)

I.

1. The holders of the medal for eminence in the application of science to the public welfare shall be notified, like members, of the meetings of the academy, and invited to participate in its scientific sessions.

II.

1. The proper secretary shall acknowledge all donations made to the academy, and shall at once report them to the council for its consideration.

2. The home secretary shall be the custodian of all books, apparatus, archives, and collections not explicitly assigned to other care.

3. The home secretary shall keep a record of all grants of money or awards of prizes or medals made from trust funds of the academy. The record for each grant of money shall include the following items:

1. Name of fund.
2. Date and number of the grant.
3. Name and address of recipient.
4. Amount of grant and date or dates of payment.
5. Purpose of grant.
6. Record of report of progress.
7. Resulting publications.

4. The treasurer shall keep the home secretary informed of all warrants received from directors of trust funds not controlled by the academy and of the date or dates of payment of all warrants.

5. The treasurer is authorized to defray, when approved by the president, all the proper expenses of committees appointed to make scientific investigations at the request of departments of the Government, and in each case to look to the department requesting the investigation for reimbursement to the academy.

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III.

1. The annual meeting of the academy shall begin on the fourth Monday of April. At the business sessions of the academy the order of procedure shall be as follows:

1. Chair taken by the president, or, in his absence, by the vice president.
2. Roll of members called by home secretary (first session of the meeting only).
3. Minutes of the preceding session read and approved.
4. Stated business.
5. Reports of president, secretaries, treasurer, and committees.
6. Business from council.
7. Other business.

2. The rules of order of the academy shall be those of the Senate of the United States, unless otherwise provided by the constitution or rules of the academy.

3. In the absence of any officer a member shall be chosen to perform his duties temporarily, by a plurality of *viva voce* votes, upon open nomination.

4. At each meeting the president shall announce the death of any members since the preceding meeting. As soon as practicable thereafter he shall designate a member to write—or to secure from some other source approved by the president—a biographical notice of each deceased member.

5. A standing committee of three members called the program committee, a local committee of five members appointed for each meeting, and the home secretary shall together constitute the committee of arrangements, of which the home secretary shall be chairman.

The term of service on the program committee shall be three years, one member retiring annually, the chairman to be designated by the president.

It shall be the duty of the program committee to prepare the scientific program for the annual meeting, and for this purpose it shall be empowered to solicit papers from members or others. It shall also be empowered to ascertain the length of time required for reading papers to be presented at the scientific sessions of the academy, and, when it appears advisable to limit the time to be occupied in their presentation or discussion.

The local committee shall meet not less than two months previous to each meeting. It shall prepare the detailed program of each day, and in general shall have charge of all business and scientific ar-

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rangements for the meeting for which it is appointed except those specifically assigned to the program committee in the case of the annual meeting.

IV.

1. The term of service of each chairman of a section shall be three years, to date from the closing session of the April meeting next following his election. Chairmen of sections shall be chosen by mail ballot, the member receiving the highest number of votes cast to be deemed elected. It shall be the duty of each retiring chairman to conduct the election of his successor and to report the result of the election to the home secretary before the April meeting at which his term of service expires. Should any section fail to elect a chairman before November 1, the president is empowered to appoint a temporary chairman to serve until the April meeting next following. No chairman shall be eligible for reelection for two consecutive terms.

2. The chairman of each section of the academy shall submit to the members of his section, not later than November 1 of each year, a ballot containing the names of all those persons who received not less than two votes in the nominating ballot of the preceding year and of any other persons who were newly proposed for consideration at that time. Each member of the section shall be expected to return this ballot to the chairman within two weeks with his signature and with crosses placed against the names of those persons whom he is prepared to indorse for nomination. Each member may also write upon the ballot in a place provided for the purpose any new names which he desires to have included in the ballot to be submitted to the section in the following year. The vote resulting from this ballot shall be regarded as informal.

The chairman shall then submit to the members of his section a new ballot showing the results of the informal vote; and each member shall be expected to return this ballot to the chairman with his signature and with crosses placed against the names of those persons whom he will indorse for nomination. In order to secure an adequate number of nominations, the chairman, when necessary, shall obtain by personal solicitation a fuller vote of his section or shall submit to the section a supplementary formal ballot.

The chairman shall then certify to the home secretary, prior to January 1, the names of those persons who have been voted for on the formal ballots by a majority of the members of the section, and shall furnish him a list of the publications of these nominees, as required by the constitution.

3. Nominations for membership shall give the full name, residence, and the official positions successively held by the candidate, in addi-

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tion to the list of his contributions to science required by the constitution.

4. Preference ballots for election of members shall be sealed in a blank envelope, which shall be inclosed in another bearing the name of the sender, and which shall be addressed to the home secretary. Such envelopes shall be opened only by the tellers. If in any case the tellers are unable to determine who cast a ballot, or if the latter contains more names than are to be voted for, the ballot shall be rejected, but minor defects in a ballot shall be disregarded when the intent of the voter is obvious.

5. All discussions of the claims and qualifications of nominees at meetings of the academy shall be held strictly confidential, and remarks and criticisms then made may be communicated to no person who was not a member of the academy at the time of the discussion.

V.

1. The publication of the proceedings shall be under the general charge of the council, which shall have final jurisdiction upon all questions of policy relating thereto. The preparation of the proceedings for publication shall be intrusted to an editorial board. This board shall consist of a chairman and a managing editor, both of whom shall be appointed by the council for definite terms of service; of the home secretary and foreign secretary *ex officiis*, and of a body of associate editors representing the various branches of science which are to be included in the scope of the proceedings. The managing editor, who may be a nonmember of the academy, shall receive a salary, which shall be fixed by the council. It shall be the duty of the managing editor to prepare the proceedings in detail for publication; but the chairman of the editorial board shall decide, in consultation with the managing editor, in regard to the acceptance, rejection, or substantial modification of papers offered for publication. The associate editors shall be appointed by the council, upon recommendation of the chairman of the editorial board, for a period of three years, one-third of them retiring annually. The home secretary and the foreign secretary shall be responsible for the distribution of the proceedings in their respective fields.

2. Memoirs may be presented at any time to the home secretary, who shall report the date of their reception at the next session; but no memoir shall be published unless it has been read or presented by title before the academy.

Before publication all biographical and scientific memoirs must be referred to the committee on publication, who may, if they deem best, refer any memoir to a special committee appointed by the president to determine whether the same should be published by the academy.

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3. Memoirs shall date, in the records of the academy, from the date of their presentation to the academy, and the order of their presentation shall be so arranged by the secretary that, so far as may be convenient, those upon kindred topics shall follow one another.

4. The annual report of the treasurer shall contain:

1. A concise statement of the source, object, and amount of all trust funds of the academy.
2. A condensed statement of receipts and expenditures.
3. A statement of assets and liabilities.
4. Accounts with individual funds.
5. Such other matter as he considers appropriate.

5. The accounts of the treasurer shall, between January 1 and January 15 of each year, be audited by a committee of three members to be appointed by the president at the autumn meeting of the academy. It shall be the duty of the auditing committee to verify the record of receipts and disbursements maintained by the treasurer and the agreement of book and bank balances; to examine all securities in the custody of the treasurer and to compare the stated income of such securities with the receipts of record; to examine all vouchers covering disbursements for account of the academy and the authority therefor and to compare them with the treasurer's record of expenditures; to examine and verify the account of the academy with each trust fund. The auditing committee may employ an expert accountant to assist the committee in the examination of the books of the treasurer. The annual report of the treasurer shall be published with that of the president to Congress. The reports of the treasurer and auditing committee shall be presented to the academy at the annual meeting.

VI.

1. All apparatus and other materials of permanent value purchased with money from any grant from a trust fund shall be the property of the academy unless specific exception is made in the grant or by subsequent action of the council or the directors of the trust fund concerned. Receipts for all such property shall be signed by the grantee and shall be forwarded to the home secretary. All apparatus and unused material of value acquired in this way shall be delivered to the home secretary on completion of the investigation for which the grant was made, or at any time on demand of the council, and the home secretary shall give an appropriate release therefor.

2. The books, apparatus, archives, and other collections of the academy shall be deposited in some safe place in the city of Washington. A list of the articles so deposited shall be kept by the home secretary, who is authorized to employ a clerk to take charge of them.

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3. A stamp corresponding to the corporate seal of the academy shall be kept by the secretaries, who shall be responsible for the due markings of all books and other objects to which it is applicable.

Labels or other proper marks of similar device shall be placed upon objects not admitting of the stamp.

4. The fiscal year of the academy shall end on December 31 of each year.

5. The standing committee on finance shall consist of the treasurer ex officio as chairman and two members to be appointed annually by the president.

VII.

1. Standing committees of the academy on trust funds the income of which is applied to the promotion of research shall consist of three or five members. In order to secure rotation in office in such committees, when not in conflict with the provisions of the deeds of gift, the term of service on a committee of three members shall be three years; on a committee of five members the term shall be five years.

2. The annual reports of the committees on research funds shall, so far as the academy has authority to determine their form, give a current number to each award, stating the name, position, and address of the recipient; the subject of research for which the award is made, and the sum awarded; and in later annual reports the status of the work accomplished under each award previously made shall be announced, until the research is completed, when announcement of its completion and, if published, the title and place of publication shall be stated, and the record of the award shall be reported as closed.

VIII.

1. Any rule of the academy may be amended, suspended, or repealed on the written motion of any two members, signed by them, and presented at a stated meeting of the academy, provided the same shall be approved by a majority of the members present.

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APPENDIX C.

ORGANIZATION OF THE ACADEMY, 1918–19.

	Expiration of term.
WALCOTT, CHARLES D., *President*	April, 1923
MICHELSON, A. A., *Vice President*	April, 1923
HALE, GEORGE E., *Foreign Secretary*	April, 1922
ABBOT, C. G., *Acting Home Secretary*	April, 1919
CROSS, WHITMAN, *Treasurer*	April, 1923

ADDITIONAL MEMBERS OF COUNCIL.

1918–1919.

CHITTENDEN, R. H. — PUPIN, M. I.

1917–1920.

CONKLIN, E. G. — NOYES, A. A.

1918–1921.

ABBOT, C. G. — HOWELL, W. H.

SECTIONS.

1. MATHEMATICS.

BIRKHOFF, G. D.
BLISS, G. A.
BOLZA, OSKAR
DICKSON, L. E.
KASNER, EDWARD
MOORE, E. H.
OSGOOD, W. F.
STORY, W. E.
VAN VLECK, E. B. (*Chairman, 1916–1919*)
WHITE, H. S.

2. ASTRONOMY.

ABBOT, C. G.
ADAMS, W. S.
AITKEN, R. G.
BARNARD, E. E.
CAMPBELL, W. W. (*Chairman, 1917–1920*)
COMSTOCK, G. C.
ELKIN, W. L.
FROST, E. B.
LEUSCHNER, A. O.
HALE, G. E.
MOULTON, F. R.
RUSSELL, H. N.
SCHLESINGER, FRANK

3. PHYSICS.

ABBOT, H. L.
AMES, J. S.
BARUS, CARL
BELL, A. G.
BRIDGMAN, P. W.
BUMSTEAD, H. A.
CARTY, J. J.
CREW, HENRY
DURAND, W. F.
FREEMAN, J. R.
HALL, E. H.
HASTINGS, C. S.
HAYFORD, J. F.
JEWETT, F. B.
LYMAN, THEODORE
MENDELHALL, C. E.
MENDENHALL, T. C.
MERRITT, ERNEST
MICHELSON, A. A.
MILLIKAN, R. A.
NICHOLS, E. F. (*Chairman, 1917–1920*)
NICHOLS, E. L.
PUPIN, M. I.
ROSA, E. B.
SABINE, W. C.
STRATTON, S. W.
TAYLOR, D. W.
THOMSON, ELIHU
TROWBRIDGE, JOHN
WEBSTER, A. G.
WOOD, R. W.
WOODWARD, R. S.

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4. CHEMISTRY.

BAXTER, G. P.
BOGERT, M. T.
BOLTWOOD, B. B.
CHANDLER, C. F.
CLARKE, F. W.
FRANKLIN, E. C.
GOMBERG, MOSES
GOOCH, F. A.
HILLEBRAND, W. F.
HOWE, H. M.
JACKSON, C. L.
LANGMUIR, IRVING
LEWIS, G. N.
MICHAEL, ARTHUR
MORLEY, E. W.
MORSE, H. N.
NOYES, A. A.
NOYES, W. A.
OSBORNE, T. B.
REMSEN, IRA
RICHARDS, T. W. (*Chairman, 1916–1919*)
SMITH, ALEXANDER
SMITH, EDGAR F.
STIEGLITZ, JULIUS
WELLS, H. L.
WHITNEY, W. R.

5. GEOLOGY AND PALEONTOLOGY.

BECKER, G. F.
BRANNER, J. C.
CHAMBERLIN, T. C.
CLARKE, J. M. (*Chairman, 1918–1921*)
CROSS, WHITMAN
DALL, W. H.
DANA, E. S.
DAVIS, W. M.
DAY, A. L.
IDDINGS, J. P.
KEMP, J. F.
LINDGREN, WALDEMAR
MERRIAM, J. C.
OSBORN, H. F.
PIRSSON, L. V.
PUMPELLY, RAPHAEL
RANSOME, F. L.
REID, H. F.
SCHUCHERT, CHARLES
SCOTT, W. B.
ULRICH, E. O.
WALCOTT, C. D.
WHITE, DAVID

6. BOTANY.

BAILEY, L. H.
BRITTON, N. L.
CAMPBELL, D. H.
COULTER, J. M.
FARLOW, W. G.
GOODALE, G. L.
HARPER, R. A.
SARGENT, C. S.
SMITH, ERWIN F. (*Chairman, 1918–1921*)
THAXTER, ROLAND
TRELEASE, WILLIAM

7. ZOOLOGY AND ANIMAL MORPHOLOGY.

ALLEN, J. A.
CASTLE, W. E.
CONKLIN, E. G.
DAVENPORT, C. B.
DONALDSON, H. H.
FORBES, S. A.
HARRISON, R. G.
HERRICK, C. J.
HOWARD, L. O.
JENNINGS, H. S.
LILLIE, F. R.
MARK, E. L.
MAYOR, A. G.
MERRIAM, C. H.
MORGAN, T. H.
MORSE, E. S.
PARKER, G. H. (*Chairman, 1916–1919*)
PEARL, RAYMOND
RIDGWAY, ROBERT
VERRILL, A. E.
WHEELER, W. M.
WILSON, EDMUND B.

8. PHYSIOLOGY AND PATHOLOGY.

ABEL, J. J.
BENEDICT, F. G.
CANNON, W. B.
CHITTENDEN, R. H.
COUNCILMAN, W. T.
CUSHING, HARVEY
FLEXNER, SIMON
FOLIN, OTTO
HALSTED, W. S.
HEKTOEN, LUDVIG
HOWELL, W. H. (*Chairman, 1916–1919*)
JONES, WALTER
LEVENE, P. A. T.
LOEB, JACQUES
LUSK, GRAHAM
MELTZER, S. J.
MENDEL, L. B.
PRUDDEN, T. M.
SMITH, THEOBALD
VAUGHAN, V. C.
WELCH, W. H.
WOOD, H. C.

9. ANTHROPOLOGY AND PSYCHOLOGY.

BOAS, FRANZ.
CATTELL, J. MCK.
DEWEY, JOHN.
FEWKES, J. W. (*Acting Chairman*).
HALL, G. S.
HOLMES, W. H.
THORNDIKE, E. L.

STANDING COMMITTEES.

ON WEIGHTS, MEASURES, AND COINAGE.

MENDENHALL, T. C. (*Chairman*). MICHELSON, A. A. MORLEY, E. W.
WEBSTER, A. G. WOODWARD, R. S.

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ON SOLAR RESEARCH.

HALE, G. E. (*Chairman*). CAMPBELL, W. W. MICHELSON, A. A.
NICHOLS, E. L. PICKERING, E. C.

ON PUBLICATION.

The PRESIDENT. The HOME SECRETARY. ROSA, E. B.

EDITORIAL BOARD OF THE PROCEEDINGS.

PEARL, RAYMOND (*Chairman*). WILSON, EDWIN B. (*Managing Editor*).
ABBOT, C. G. (*Acting Home Secretary*). HALE, G. E. (*Foreign Secretary*).

CLARKE, J. M., 1921.	JENNINGS, H. S., 1921.	MOORE, E. H., 1920.
DONALDSON, H. H., 1919.	LOEB, JACQUES, 1920.	NOYES, A. A., 1919.
FROST, E. B., 1920.	LUSK, GRAHAM, 1919.	NOYES, W. A., 1921.
HARPER, R. A., 1919.	MAYOR, A. G., 1919.	THORNDIKE, E. L., 1920.
HEKTOEN, LUDVIG, 1921.	MILLIKAN, R. A., 1921.	WHEELER, W. M., 1920.

ON COLLECTION OF HISTORICAL PORTRAITS, MANUSCRIPTS, INSTRUMENTS, ETC.

WALCOTT, C. D. (*Chairman*). CLARKE, F. W. HALE, G. E.
MELTZER, S. J. PUPIN, M. I.

ON PROGRAM.

J. C. MERRIAM (*Chairman*), 1921. PEARL, RAYMOND, 1920.
THORNDIKE, E. L., 1919.

FINANCE COMMITTEE.

CROSS, WHITMAN (*Chairman*). HOWARD, L. O. WALCOTT, C. D.

TRUST FUNDS.

THE BACHE FUND.

[$59,000.]

Researches in physical and natural science.

FROST, E. B. (*Chairman*) HARRISON, R. G. WEBSTER, A. G.

THE WATSON FUND.

[$25,000.]

Watson medal and the promotion of astronomical research.

LEUSCHNER, A. O. (*Chairman*). COMSTOCK, G. C. ELKIN, W. L.

THE HENRY DRAPER FUND.

[$10,000.]

Draper medal and investigations in astronomical physics.

CAMPBELL, W. W. (*Chairman*), 1919. ABBOT, C. G., 1921. AMES, J. S., 1920.
HALE, G. E., 1923. MICHELSON, A. A., 1922.

THE J. LAWRENCE SMITH FUND.

[$10,000.]

J. Lawrence Smith medal and investigations of meteoric bodies.

MORLEY, E. W. (*Chairman*), 1919. DANA, E. S., 1923. CROSS, WHITMAN, 1922.
PICKERING, E. C., 1920. WOOD, R. W., 1921.

THE BARNARD MEDAL.[1]

Meritorious service to science.

NOYES, A. A. (*Chairman*). CAMPBELL, W. W. NICHOLS, E. F.
MORGAN, T. H. RICHARDS, T. W.

[1] Every five years the committee recommends the person whom they consider most deserving of the medal, and upon the approval of the academy the name of the nominee is forwarded to the trustees of Columbia University, who administer the Barnard Medal Fund.

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THE BENJAMIN APTHORP GOULD FUND.

[$20,000.]

Researches in astronomy.

MOULTON, F. R. (*Chairman*). BARNARD, E. E. WOODWARD, R. S.

THE WOLCOTT GIBBS FUND.

[$5,545.50.]

Chemical research.

JACKSON, C. L. (*Chairman*). RICHARDS, T. W. SMITH, EDGAR F.

THE COMSTOCK FUND.

[$12,406.02.]

Researches in electricity, magnetism, and radiant energy.

NICHOLS, E. L. (*Chairman*), 1923. MILLIKAN, R. A., 1921. NOYES, A. A., 1919.
THOMPSON, ELIHU, 1920. WEBSTER, A. G., 1922.

THE MARSH FUND.

[$19,000.]

Original research in the natural sciences.

MOORE, E. H. (*Chairman*), 1919. DANA, E. S., 1920.
SCHUCHERT, CHARLES, 1921.

THE AGASSIZ FUND.

[$50,000.]

General uses of the academy.

THE MURRAY FUND.

[$6,000.]

Agassiz medal and contributions to oceanography.

DALL, W. H. (*Chairman*), 1921. DAVIS, W. M., 1919. PARKER, G. H., 1920.

THE MARCELLUS HARTLEY FUND.

[$1,200.]

Medal for Eminence in the Application of Science to the Public Welfare.

BECKER, G. F. (*Chairman*), 1919. HILLEBRAND, W. F., 1919.
OSBORN, H. F., 1921. PUPIN, M. I., 1921. SMITH, THEOBALD, 1920.
WEBSTER, A. G., 1920.

THE JOSEPH HENRY FUND.

To assist meritorious investigators, especially in the direction of original research.

The sum of $40,000 was contributed by Fairman Rogers, Joseph Patterson, George W. Childs, and others, as an expression of their respect and esteem for Prof. Joseph Henry. This amount was deposited with the Pennsylvania Co. for the Insurance of Lives and Granting Annuities in Trust, with authorization to collect the income thereon and to pay over the same to Prof. Joseph Henry during his natural life, and after his death to his wife and daughters, and after the death of the last survivor to "deliver the said fund and the securities in which it shall then be invested to the National Academy of Sciences, to be thenceforward forever held in trust under the name and title of the 'Joseph Henry fund.'"

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MEMBERS OF THE NATIONAL ACADEMY OF SCIENCES.

DECEMBER 31, 1918.

	Date of election.
ABBOT, CHARLES GREELEY—*Smithsonian Institution, Washington, D. C.*	1915
ABBOT, HENRY L., U. S. A—*23 Berkeley St., Cambridge, Mass.*	1872
ABEL, JOHN JACOB—*Johns Hopkins University, Baltimore, Md.*	1912
ADAMS, WALTER SYDNEY—*Solar Observatory Office, Pasadena, Cal.*	1917
AITKEN, ROBERT GRANT—*Lick Observatory, Mount Hamilton, Cal.*	1918
ALLEN, J. ASAPH—*American Museum of Natural History, N. Y. City.*	1876
AMES, JOSEPH S—*Johns Hopkins University, Baltimore, Md.*	1909
BAILEY, LIBERTY HYDE—*Ithaca, N. Y.*	1917
BARNARD, E. E—*Yerkes Observatory, Williams Bay, Wis.*	1911
BARUS, CARL—*Brown University, Providence, R. I.*	1892
BAXTER, GREGORY PAUL—*T. J. Coolidge, jr., Mem. Lab., Cambridge, Mass.*	1916
BECKER, GEORGE F—*U. S. Geological Survey, Washington, D. C.*	1901
BELL, A. GRAHAM—*1331 Connecticut Ave., Washington, D. C.*	1883
BENEDICT, FRANCIS GANO—*Nutrition Laboratory, Boston, Mass.*	1914
BIRKHOFF, GEORGE DAVID—*Harvard University, Cambridge, Mass.*	1918
BLISS, GILBERT AMES—*University of Chicago, Chicago, Ill.*	1916
BOAS, FRANZ—*Columbia University, New York City.*	1900
BOGERT, MARSTON TAYLOR—*Chemical Warfare Service, U. S. Army Unit F, 7th and B Streets NW., Washington, D. C.*	1916
BOLTWOOD, B. B—*Yale University, New Haven, Conn.*	1911
BOLZA, OSKAR—*Reichsgrafenstr. 10, Freiburg, Germany.*	1909
BRANNER, JOHN C—*Stanford University, California.*	1905
BRIDGMAN, PERCY WILLIAMS —*Jefferson Physical Laboratory, Cambridge, Mass.*	1918
BRITTON, NATHANIEL LORD—*New York Botanical Gardens, N. Y. City.*	1914
BUMSTEAD, HENRY ANDREWS—*Yale University, New Haven, Conn.*	1913
CAMPBELL, D. H—*Stanford University, California.*	1910
CAMPBELL, WILLIAM W—*Lick Observatory, Mount Hamilton, Cal.*	1902
CANNON, WALTER BRADFORD—*Harvard University, Cambridge, Mass.*	1914
CARTY, JOHN J—*Am. Telegraph and Telephone Co., N. Y. City.*	1917
CASTLE, WILLIAM ERNEST—*186 Payson Road, Belmont, Mass.*	1915
CATTELL, JAMES MCK—*Garrison, N. Y.*	1901
CHAMBERLIN, THOMAS C—*University of Chicago, Chicago, Ill.*	1903
CHANDLER, CHARLES F—*Columbia University, New York City.*	1874
CHITTENDEN, RUSSELL H—*Sheffield Scientific School, New Haven, Conn.*	1890
CLARKE, F. W—*U. S. Geological Survey, Washington, D. C.*	1909
CLARKE, J. M—*State Hall, Albany, N. Y.*	1909
COMSTOCK, GEORGE C—*Washburn Observatory, Madison, Wis.*	1899
CONKLIN, E. G—*Princeton, N. J.*	1908
COULTER, J. M—*University of Chicago, Chicago, Ill.*	1909
COUNCILMAN, WILLIAM T—*Harvey Medical School, Boston, Mass.*	1904
CREW, HENRY—*Northwestern University, Evanston, Ill.*	1909
CROSS, WHITMAN—*2138 Bancroft Place, Washington, D. C.*	1908

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		Date of election.
CUSHING, HARVEY	*Harvard University, Cambridge, Mass.*	1917
DALL, WILLIAM H	*Smithsonian Institution, Washington, D. C.*	1897
DANA, EDWARD S.	*Yale University, New Haven, Conn.*	1884
DAVENPORT, CHARLES B	*Cold Spring Harbor, N. Y.*	1912
DAVIS, WILLIAM MORRIS	*31 Hawthorn St., Cambridge, Mass.*	1904
DAY, ARTHUR L.	*Corning Glass Works, P. O. Box 544, Corning, N. Y.*	1911
DEWEY, JOHN	*Columbia University, New York City.*	1910
DICKSON, LEONARD E	*University of Chicago, Chicago, Ill.*	1913
DONALDSON, HENRY HERBERT	*Wistar Institute of Anatomy, Phila., Pa.*	1914
DURAND, WILLIAM FREDERICK	*Leland Stanford University, Cal.*	1917
ELKIN, WILLIAM L.	*Yale University Observatory, New Haven, Conn.*	1895
FARLOW, W. G.	*Harvard University, Cambridge, Mass.*	1879
FEWKES, JESSE WALTER	*Bureau of American Ethnology, Wash., D. C.*	1914
FLEXNER, SIMON	*Rockefeller Institute, New York City.*	1908
FOLIN, OTTO	*Harvard Medical School, Boston, Mass.*	1916
FORBES, STEPHEN ALFRED	*Urbana, Ill.*	1918
FRANKLIN, EDWARD CURTIS	*Stanford University, California.*	1914
FREEMAN, JOHN RIPLEY	*Providence, R. I.*	1918
FROST, EDWIN B	*Yerkes Observatory, Williams Bay, Wis.*	1908
GOMBERG, MOSES	*University of Michigan, Ann Arbor, Mich.*	1914
GOOCH, FRANK A	*291 Edwards St., New Haven, Conn.*	1897
GOODALE, GEORGE L	*Harvard University, Cambridge, Mass.*	1890
HALE, GEORGE E	*Solar Observatory Office, Pasadena, Cal.*	1902
HALL, EDWIN H	*Harvard University, Cambridge, Mass.*	1911
HALL, GRANVILLE STANLEY	*Clark University, Worcester, Mass.*	1915
HALSTED, WILLIAM STEWART,	*Johns Hopkins Med. School, Baltimore, Md.*	1917
HARPER, R. A	*Columbia University, New York City.*	1911
HARRISON, ROSS G	*Yale University, New Haven, Conn.*	1913
HASTINGS, CHARLES S	*Yale University, New Haven, Conn.*	1889
HAYFORD, JOHN F	*Northwestern University, Evanston, Ill.*	1911
HEKTOEN, LUDVIG	*629 South Wood St., Chicago, Ill.*	1918
HERRICK, CHARLES JUDSON	*University of Chicago, Chicago, Ill.*	1918
HILLEBRAND, WILLIAM F	*Bureau of Standards, Washington, D. C.*	1908
HOLMES, WILLIAM H	*U. S. National Museum, Washington, D. C.*	1905
HOWARD, LELAND OSSIAN	*U. S. Dept. of Agriculture, Washington, D. C.*	1916
HOWE, HENRY MARION	*Broad Brook Road, Bedford Hills, N. Y.*	1917
HOWELL, WILLIAM H	*Johns Hopkins University, Baltimore, Md.*	1905
IDDINGS, JOSEPH P	*U. S. Geological Survey, Washington, D. C.*	1907
JACKSON, CHARLES L.	*6 Boylston Hall, Cambridge, Mass.*	1883
JENNINGS, HERBERT SPENCER	*Johns Hopkins University, Baltimore, Md.*	1914
JEWETT, FRANK BALDWIN	*Western Electric Co., New York, N. Y.*	1918
JONES, WALTER	*Johns Hopkins University, Baltimore, Md.*	1918
KASNER, EDWARD	*Columbia University, New York City.*	1917
KEMP, JAMES F.	*Columbia University, New York City.*	1911
LANGMUIR, IRVING	*Gen. Electric Co., Schenectady, N. Y.*	1918
LEUSCHNER, ARMIN O	*University of California, Berkeley, Cal.*	1913
LEVENE, PHOEBUS AARON THEODOR	*Rockefeller Institute, New York City.*	1916
LEWIS, GILBERT N.	*University of California, Berkeley, Cal.*	1913
LILLIE, FRANK RATTRAY	*University of Chicago, Chicago, Ill.*	1915
LINDGREN, WALDEMAR	*Mass. Inst. of Technology, Cambridge, Mass.*	1909
LOEB, JACQUES	*Rockefeller Institute, New York City.*	1910

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		Date of election
LUSK, GRAHAM	*Cornell University Medical College, New York City.*	1915
LYMAN, THEODORE	*Harvard University, Cambridge, Mass.*	1917
MARK, EDWARD L	*109 Irving St., Cambridge, Mass.*	1903
MAYOR, ALFRED GOLDSBOROUGH	*276 Nassau St., Princeton, N. J.*	1916
MELTZER, SAMUEL JAMES	*Rockefeller Institute, New York City.*	1912
MENDEL, LAFAYETTE B	*262 Canner St., New Haven, Conn.*	1913
MENDENHALL, CHARLES ELWOOD	*University of Wisconsin, Madison, Wis.*	1918
MENDENHALL, THOMAS C	*329 North Chestnut St., Ravenna, Ohio.*	1887
MERRIAM, C. HART	*1919 16th St., Washington, D. C.*	1902
MERRIAM, JOHN CAMPBELL	*University of California, Berkeley, Cal.*	1918
MERRITT, ERNEST	*Cornell University, Ithaca, N. Y.*	1914
MICHAEL, ARTHUR	*219 Parker St., Newton Center, Mass.*	1889
MICHELSON, ALBERT A	*University of Chicago, Chicago, Ill.*	1888
MILLIKAN, ROBERT ANDREWS	*University of Chicago, Chicago, Ill.*	1915
MOORE, ELIAKIM H	*University of Chicago, Chicago, Ill.*	1901
MORGAN, T. H.	*Columbia University, New York City.*	1909
MORLEY, EDWARD W	*West Hartford, Conn.*	1897
MORSE, EDWARD S	*Salem, Mass.*	1876
MORSE, HARMON N	*Johns Hopkins University, Baltimore, Md.*	1907
MOULTON, F. R	*University of Chicago, Chicago, Ill.*	1910
NICHOLS, EDWARD L	*Cornell University, Ithaca, N. Y.*	1901
NICHOLS, ERNEST F	*Yale University, New Haven, Conn.*	1908
NOYES, ARTHUR A	*Mass. Inst. of Technology, Cambridge, Mass.*	1905
NOYES, WILLIAM A	*University of Illinois, Urbana, Ill.*	1910
OSBORN, H. F	*American Museum of Natural History, New York City.*	1900
OSBORNE, T. B	*Agricultural Experiment Station, New Haven, Conn.*	1910
OSGOOD, WILLIAM FOGG	*Harvard University, Cambridge, Mass.*	1904
PARKER, GEORGE H	*16 Berkeley St., Cambridge, Mass.*	1913
PEARL, RAYMOND	*School of Hygiene and Public Health, 310 West Monument St., Baltimore, Md.*	1916
PICKERING, EDWARD C	*Harvard College Observatory, Cambridge, Mass.*	1873
PIRSSON, LOUIS V	*41 Trumbull St., New Haven, Conn.*	1913
PRUDDEN, T. MITCHELL	*Columbia University, New York City.*	1901
PUMPELLY, RAPHAEL	*Gibbs Avenue, Newport, R. I.*	1872
PUPIN, MICHAEL I	*Columbia University, New York City.*	1905
RANSOME, FREDERICK LESLIE	*U. S. Geological Survey, Washington, D. C.*	1914
REID, H. FIELDING	*Johns Hopkins University, Baltimore, Md.*	1912
REMSEN, IRA	*Johns Hopkins University, Baltimore, Md.*	1882
RICHARDS, THEODORE W	*Wolcott Gibbs Mem. Lab., Cambridge, Mass.*	1899
RIDGWAY, ROBERT	*1030 South Morgan St., Olney, Ill.*	1917
ROSA, EDWARD B	*Bureau of Standards, Washington, D. C.*	1913
RUSSELL, HENRY NORRIS	*Princeton University, Princeton, N. J.*	1918
SABINE, WALLACE C	*Harvard University, Cambridge, Mass.*	1917
SARGENT, CHARLES S	*Arnold Arboretum, Jamaica Plain, Mass.*	1895
SCHLESINGER, FRANK	*Allegheny Observatory, Alelgheny, Pa.*	1916
SCHUCHERT, CHARLES	*Yale University, New Haven, Conn.*	1910
SCOTT, WILLIAM B	*Princeton University, Princeton, N. J.*	1906
SMITH, ALEXANDER	*Columbia University, New York City.*	1915
SMITH, EDGAR F	*University of Pennsylvania, Philadelphia, Pa.*	1899
SMITH, ERWIN F	*Bureau of Plant Industry, Washington, D. C.*	1913
SMITH, THEOBALD	*Princeton, N. J.*	1908
STIEGLITZ, JULIUS	*University of Chicago, Chicago, Ill.*	1911

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		Date of election.
STORY, WILLIAM E.	*Clark University, Worcester, Mass.*	1908
STRATTON, SAMUEL WESLEY	*Bureau of Standards, Washington, D. C.*	1917
TAYLOR, DAVID WATSON	*Department of the Navy, Washington, D. C.*	1918
THAXTER, ROLAND	*Harvard University, Cambridge, Mass.*	1912
THOMSON, ELIHU	*Swampscott, Mass.*	1907
THORNDIKE, EDWARD LEE	*Columbia University, New York City.*	1917
TRELEASE, WILLIAM	*University of Illinois, Urbana, Ill.*	1902
TROWBRIDGE, JOHN	*Harvard University, Cambridge, Mass.*	1878
ULRICH, EDWARD OSCAR	*U. S. Geological Survey, Washington, D. C.*	1917
VAN VLECK, E. B.	*University of Wisconsin, Madison, Wis.*	1911
VAUGHAN, VICTOR CLARENCE	*University of Michigan, Ann Arbor, Mich.*	1915
VERRILL, A. E.	*53 Rolston St., Whitneyville, Conn.*	1872
WALCOTT, CHARLES D.	*Smithsonian Institution, Washington, D. C.*	1896
WEBSTER, ARTHUR G.	*Clark University, Worcester, Mass.*	1903
WELCH, WILLIAM H.	*307 St. Paul St., Baltimore, Md.*	1895
WELLS, HORACE L.	*Yale University, New Haven, Conn.*	1903
WHEELER, WILLIAM M.	*Harvard University, Cambridge, Mass.*	1912
WHITE, DAVID	*U. S. Geological Survey, Washington, D. C.*	1912
WHITE, HENRY SEELY	*Vassar College, Poughkeepsie, N. Y.*	1915
WHITNEY, WILLIS RODNEY	*General Electric Co., Schenectady, N. Y.*	1917
WILSON, EDMUND B.	*Columbia University, New York City.*	1899
WOOD, HORATIO C.	*4107 Chester Avenue, Philadelphia, Pa.*	1879
WOOD, ROBERT W.	*Johns Hopkins University, Baltimore, Md.*	1912
WOODWARD, ROBERT S.	*Carnegie Institution, Washington, D. C.*	1896

HONORARY MEMBERS.

SMITH, SIDNEY I.	*Yale University, New Haven, Conn.*	1884

FOREIGN ASSOCIATES.

ARRHENIUS, S. A.	*Nobelinstitut, Stockholm.*	1908
BARROIS, CHARLES	*Université, Lille.*	1908
BRØGGER, W. C.	*Universitet, Christiania.*	1903
CROOKES, SIR WILLIAM	*London.*	1913
DESLANDRES, HENRI	*Astrophysical Observatory, Meudon.*	1913
DEWAR, SIR JAMES	*University, Cambridge.*	1907
FISCHER, EMIL	*Chemisches Institut der Universität, Berlin.*	1904
FORSYTH, A. R.	*Imperial College of Science and Technology, London.*	1907
GEIKIE, SIR ARCHIBALD	*Haslemere, Surrey.*	1901
GROTH, PAUL VON	*Universität, Munich.*	1905
HEIM, ALBERT	*Zürich.*	1913
HILBERT, DAVID	*Universität, Göttingen.*	1907
KAPTEYN, JOHN C.	*Rijks Universiteit, Groningen.*	1907
KLEIN, FELIX	*Universität, Göttingen.*	1898
KÖSSEL, ALBRECHT	*Heidelberg.*	1913
KUSTNER, KARL FRIEDRICH	*Bonn.*	1913
LANKESTER, SIR E. RAY	*South Kensington, London.*	1903
LARMOR, SIR JOSEPH	*St. Johns College, Cambridge.*	1908
LORENTZ, HENDRIK ANTON	*Rijks Universiteit, Leiden.*	1906
OSTWALD, WILHELM	*Grossbothen, bei Leipzig.*	1906
PAVLOV, IVAN PETROVITCH	*Inst. for Experimental Medicine, Petrograd.*	1908
PENCK, ALBRECHT	*Universität, Berlin.*	1909

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		Date of election.
PFEFFER, WILHELM	*Botanische Institut der Universität, Leipzig.*	1908
PICARD, CHARLES ÉMILE	*Université, Paris.*	1908
RAYLEIGH, LORD	*University, Cambridge.*	1898
RETZIUS, GUSTAV	*Högskolan, Stockholm.*	1909
RUTHERFORD, SIR ERNEST	*University, Manchester.*	1911
SCHUSTER, ARTHUR	*Secretary of the Royal Society, London.*	1912
SEELIGER, HUGO RITTER VON	*Universität, Munich.*	1908
THOMSON, SIR JOSEPH	*University, Cambridge.*	1908
VOLTERRA, VITO	*Università, Rome.*	1911
VRIES, HUGO DE	*Universiteit, Amsterdam.*	1904
WAALS, JOHANNES D. VAN DER	*Amsterdam.*	1913
WALEYER, WILHELM	*Universität, Berlin.*	1909
WOLF, MAX F. J. C.	*Heidelberg.*	1913
WUNDT, WILHELM	*Universität, Leipzig.*	1909

DECEASED MEMBERS.

	Date of election.	Date of death.
ABBE, CLEVELAND	1878 [2]	Oct. 28, 1916
AGASSIZ, ALEXANDER	1866	Mar. 27, 1910
AGASSIZ, LOUIS	(1)	Dec. 14, 1873
ATKINSON, GEORGE FRANCIS	1918	Nov. 14, 1918
ALEXANDER, J. H.	(1)	Mar. 2, 1867
ALEXANDER, STEPHEN	(1)	June 25, 1883
BACHE, ALEXANDER DALLAS	(1)	Feb. 14, 1867
BAIRD, SPENCER F.	1864	Aug. 19, 1887
BARKER, GEORGE F.	1876 [2]	May 24, 1910
BARNARD, F. A. P.	(1) (2)	Apr. 27, 1889
BARNARD, J. G.	(1)	May 14, 1882
BARTLETT, W. H. C.	(1)	Feb. 11, 1908
BEECHER, CHARLES EMERSON	1899	Feb. 14, 1904
BILLINGS, JOHN S.	1883	Mar. 11, 1913
BÔCHER, MAXIME	1909	Sept. 12, 1918
BOSS, LEWIS	1889 [2]	Oct. 5, 1912
BOWDITCH, HENRY P.	1887 [2]	Mar. 13, 1911
BREWER, WILLIAM H.	1880 [2]	Nov. 2, 1910
BROOKS, WILLIAM KEITH	1884	Nov. 12, 1908
BROWN-SEQUARD, CHARLES E.	1868	Apr. 2, 1894
BRUSH, GEORGE JARVIS	1868 [2]	Feb. 6, 1912
CASEY, THOMAS L.	1890	Mar. 25, 1896
CASWELL, ALEXIS	(1)	Jan. 8, 1877
CHANDLER, SETH CARLO	1888 [2]	Dec. 31, 1913
CHAUVENET, WILLIAM	(1)	Dec. 13, 1870
CLARK, HENRY JAMES	1872	July 1, 1873
CLARK, WILLIAM B.	1908 [2]	July 27, 1917
COFFIN, JAMES H.	1869	Feb. 6, 1873
COFFIN, J. H. C.	(1)	Jan. 8, 1890
COMSTOCK, CYRUS B.	1884	May 29, 1910
COOK, GEORGE H.	1887	Sept. 22, 1889
COOKE, JOSIAH P.	1872	Sept. 3, 1894
COPE, EDWARD D.	1872 [2]	Apr. 12, 1897
COUES, ELLIOTT	1877	Dec. 25, 1899
CRAFTS, JAMES M.	1872 [2]	June 21, 1917

[1] Charter members, Mar. 3, 1863. [2] Biographical notices have not been presented.

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DECEASED MEMBERS—Continued.

	Date of election.	Date of death.
DALTON, J. C.	1864	Feb. 2, 1889
DANA, JAMES D.	(1) (2)	Apr. 14, 1895
DAVIDSON, GEORGE	1874 [2]	Dec. 2, 1911
DAVIS, CHARLES H.	(1)	Feb. 18, 1877
DRAPER, HENRY	1877	Nov. 20, 1882
DRAPER, JOHN W.	1877	Jan. 4, 1882
DUTTON, C. E.	1884 [2]	Jan. 4, 1912
EADS, JAMES B.	1872	Mar. 8, 1887
EMMONS, SAMUEL F.	1892	Mar. 28, 1911
ENGLEMANN, GEORGE	(1)	Feb. 4, 1884
FERREL, WILLIAM	1868	Sept. 18, 1891
FRASER, JOHN FRIES	(1)	Oct. 12, 1872
GABB, WILLIAM M.	1876	May 30, 1878
GENTH, F. A.	1872	Feb. 2, 1893
GIBBS, JOSIAH WILLARD	1879	Apr. 28, 1903
GIBBS, WOLCOTT	(1)	Dec. 9, 1908
GILBERT, GROVE KARL	1883	May 1, 1918
GILL, THEODORE NICHOLAS	1873	Sept. 25, 1914
GILLISS, JAMES MELVILLE	(1)	Feb. 9, 1865
GOODE, G. BROWN	1888	Sept. 6, 1896
GOULD, AUGUSTUS A.	(1)	Sept. 15, 1866
GOULD, BENJAMIN A.	(1) (2)	Nov. 26, 1896
GRAY, ASA	(1)	Jan. 30, 1888
GUYOT, ARNOLD	(1)	Feb. 8, 1884
HADLEY, JAMES	1872	Nov. 14, 1872
HAGUE, ARNOLD	1885 [2]	May 15, 1917
HALDEMAN, S. S.	1876	Sept. 20, 1880
HALL, ASAPH	1875	Nov. 22, 1907
HALL, JAMES	(1) (2)	Aug. 7, 1898
HAYDEN, F. V.	1873	Dec. 22, 1887
HENRY, JOSEPH	(1)	May 13, 1878
HILGARD, EUGENE W.	1872 [2]	Jan. 8, 1916
HILGARD, JULIUS E.	(1)	May 9, 1890
HILL, GEORGE WILLIAM	1874	Apr. 16, 1914
HILL, HENRY B.	1883	Apr. 6, 1903
HITCHCOCK, EDWARD	(1)	Feb. 27, 1864
HOLBROOK, J. E.	1868	Sept, 8 1871
HOLDEN, EDWARD SINGLETON	1885	Mar. 16, 1914
HUBBARD, J. S.	(1)	Aug. 16, 1863
HUMPHREYS, A. A.	(1)	Dec. 27, 1883
HUNT, T. STERY	1873 [2]	Feb. 12, 1892
HYATT, ALPHEUS	1875	Jan. 15, 1902
JAMES, WILLIAM [3]	1903	Aug. 26, 1910
JOHNSON, S. W. [1]	1866	July 21, 1909
KEELER, J. E.	1900	Aug. 12, 1900
KING, CLARENCE	1876	Dec. 24, 1901
KIRTLAND, JARED P.	1865	Dec. 10, 1877
LANE, J. HOMER	1872	May 3, 1880
LANGLEY, SAMUEL P.	1876	Feb. 27, 1906
LEA, MATTHEW CAREY	1892	Mar. 15, 1897
LE CONTE, JOHN	1878	Apr. 29, 1891
LE CONTE, JOHN L.	(1)	Nov. 15, 1885
LE CONTE, JOSEPH	1875	July 6, 1901

(1) Charter members, Mar 3, 1863.
[1] Biographical notices have not been presented
[3] Resigned in 1908 or 1909.

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DECEASED MEMBERS—Continued.

	Date of election.	Date of death.
LEIDY, JOSEPH	(1)	Apr. 30, 1891
LESLEY, J. PETER	(1)	June 1, 1903
LESQUEREUX, LEO	1864	Oct. 20, 1889
LONGSTRETH, MIERS F	(1)	Dec. 27, 1891
LOOMIS, ELIAS	1873	Aug. 15, 1889
LOVERING, JOSEPH	1873	Jan. 18, 1892
LYMAN, THEODORE	1872	Sept. 9, 1897
MAHAN, D. H	(1)	Sept. 16, 1871
MALL, FRANKLIN P	1907 [2]	Nov. 17, 1917
MARSH, G. P	1866	July 23, 1892
MARSH, O. C	1874 [2]	Mar. 18, 1899
MAYER, ALFRED M	1872	July 13, 1897
MAYO-SMITH, RICHMOND	1890 [2]	Nov. 11, 1901
MEEK, F. B	1869	Dec. 21, 1876
MEIGS, M. C	1865	Jan. 2, 1892
MINOT, CHARLES SEDGWICK	1897 [2]	Nov. 19, 1914
MITCHELL, HENRY	1885 [2]	Dec. 1, 1902
MITCHELL, SILAS WEIR	1865 [2]	Jan. 4, 1914
MORGAN, LEWIS H	1875	Dec. 17, 1881
MORTON, HENRY	1874	May 9, 1902
NEF, JOHN ULRIC	1904 [2]	Aug. 13, 1915
NEWBERRY, J. S	(1)	Dec. 7, 1892
NEWCOMB, SIMON	1869 [2]	July 11, 1909
NEWTON, H. A	(1)	Aug. 12, 1896
NEWTON, JOHN	1876	May 1, 1895
NORTON, WILLIAM A	1873	Sept. 21, 1883
OLIVER, JAMES E	1872	Mar. 27, 1895
PACKARD, A. S	1872 [2]	Feb. 14, 1905
PENFIELD, SAMUEL L	1900	Aug. 13, 1906
PETERS, C. H. F	1876 [2]	July 18, 1890
PEIRCE, BENJAMIN [3]	(1)(3)	Oct. 6, 1880
PEIRCE, BENJAMIN OSGOOD	1906 [2]	Jan. 14, 1914
PIERCE, CHARLES SANTIAGO SANDERS	1876 [2]	Apr. 20, 1914
POURTALES, L. F	1873	July 19, 1880
POWELL, JOHN W	1880	Sept. 23, 1902
PUTNAM, FREDERICK W	1885 [2]	Aug. 18, 1915
RODGERS, JOHN	(1)	May 5, 1882
ROGERS, FAIRMAN	(1)	Aug. 22, 1900
ROGERS, ROBERT E. [4]	(1)	Sept. 6, 1884
ROGERS, WILLIAM A	1885	Mar. 1, 1896
ROGERS, WILLIAM B. [5]	(1)	May 30, 1882
ROOD, OGDEN N	1865	Nov. 12, 1902
ROWLAND, HENRY A	1881	Apr. 16, 1901
ROYCE, JOSIAH	1906 [2]	Sept. 14, 1916
RUTHERFURD, LEWIS M	(1)	May 30, 1892
SAXTON, JOSEPH	(1)	Oct. 26, 1873
SCHOTT, CHARLES A	1872	July 31, 1901
SCUDDER, SAMUEL H	1877 [2]	May 17, 1911
SELLERS, WILLIAM	1873 [2]	Jan. 24, 1905
SILLIMAN, BENJ., Sr	(1)	Nov. 24, 1864
SILLIMAN, BENJ., Jr	(1)	Jan. 14, 1885
SMITH, J. LAWRENCE	1872	Oct. 12, 1883

[1] Charter members, Mar. 3, 1863.
[2] Biographical notices have not been presented.
[3] Resigned 1873.
[4] Dropped —, reelected 1875.
[5] Dropped —, reelected 1872.

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DECEASED MEMBERS—Continued.

	Date of election.	Date of death.
STIMPSON, WILLIAM	1868 [2]	May 26, 1872
STRONG, THEODORE	(1)	Feb. 1, 1869
SULLIVANT, W. S.	1872	Apr. 30, 1873
TORREY, JOHN	(1)	Mar. 10, 1873
TOTTEN, J. G.	(1)	Apr. 22, 1864
TROWBRIDGE, WILLIAM P.	1872	Aug. 12, 1892
TRUMBULL, JAMES H.	1872	Aug. 5, 1897
TUCKERMAN, EDWARD	1868	Mar. 15, 1886
VAN HISE, C. R.	1902	Nov. 19, 1918
WALKER, FRANCIS A.	1878	Jan. 5, 1897
WARREN, G. K.	1876	Aug. 8, 1882
WATSON, JAMES C.	1868	Nov. 23, 1880
WATSON, SERENO	1889	Mar. 9, 1892
WHEELER, HENRY LORD	1909 [2]	Oct. 30, 1914
WHITE, CHARLES A.	1889	June 29, 1910
WHITMAN, C. O.	1895	Dec. 6, 1910
WHITNEY, JOSIAH D. [3]	(1) (2)	Aug. 19, 1896
WHITNEY, WILLIAM D. [3]	1865 [2]	June 29, 1894
WILLISTON, SAMUEL WENDELL	1915	Aug. 30, 1918
WINLOCK, JOSEPH	(1)	June 11, 1875
WOODWARD, J. J.	1873	Aug. 17, 1884
WORTHEN, A. H.	1872	May 6, 1888
WRIGHT, ARTHUR WILLIAMS	1881 [2]	Dec. 19, 1915
WYMAN, JEFFRIES	(1)	Sept. 4, 1874
YOUNG, CHARLES A.	1872	Jan. 3, 1908

[1] Charter members, Mar. 3, 1863. [2] Biographical notices have not been presented. [3] Resigned.

DECEASED FOREIGN ASSOCIATES.

ADAMS, J. C.
AIRY, SIR GEORGE B.
ARGELANDER, F. W. A.
AUWERS, G. F. J. ARTHUR
BACKLUND, OSKAR
BAER, KARL ERNEST VON
BAEYER, ADOLF VON
BARRANDE, JOACHIN
BEAUMONT, L. ÉLIE DE
BECQUEREL, HENRI
BERTHELOT, M. P. E.
BERTRAND, J. L. F.
BOLTZMANN, LUDWIG
BORNET, EDOUARD
BOUSSINGAULT, J. B. J. D.
BOVERI, THEODOR
BRAUN, ALEXANDER
BREWSTER, SIR DAVID
BUNSEN, ROBERT W.
BURMEISTER, C. H. C.
CANDOLLE, ALPHONSE DE
CAYLEY, ARTHUR
CHASLES, MICHEL
CHEVREUL, M. E.
CLAUSIUS, RUDOLPH
CORNU, ALFRED
DARBOUX, GASTON
DARWIN, SIR GEORGE HOWARD
DOVE, H. W.
DUMAS, J. B.
EHRLICH, PAUL
FARADAY, MICHAEL
GEGENBAUR, KARL
GLYDÉN, HUGO
GILL, SIR DAVID
HAMILTON, SIR WILLIAM ROWAN
HELMHOLTZ, BARON H. VON
HOFF, J. H. VAN'T
HOFMANN, A. W.
HOOKER, SIR JOSEPH D.
HUGGINS, SIR WILLIAM
HUXLEY, T. H.
IBAÑEZ, CARLOS
JANSSEN, J.

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JOULE, JAMES P.
KEKULÉ, AUGUST
KELVIN, LORD
KIRCHOFF, G. R.
KOCH, ROBERT
KÖLLIKER, ALBERT VON
KOHLRAUSCH, FRIEDRICH
KRONECKER, HUGO
LACAZE-DUTHIERS, HENRI DE
LEUCKART, RUDOLPH
LIE, SOPHUS
LIEBIG, JUSTUS VON
LISTER, LORD
LOEWY, MAURICE
LUDWIG, K. F. W.
MAREY, E. J.
MENDELÉEFF, D. I.
MILNE-EDWARDS, HENRI
MOISSAN, HENRI
MURCHISON, SIR RODERICK I.
MURRAY, SIR JOHN
OPPOLZER, THEODORE VON
OWEN, SIR RICHARD
PASTEUR, LOUIS
PETERS, C. A. F.
PLANA, G. A. A.
POINCARÉ, JULES HENRI
RAMMELSBERG, C. F.
RAMSAY, SIR WILLIAM
REGNAULT, VICTOR
REYMOND, EMIL DU BOIS
RICHTHOFEN, F. VON
ROSENBUSCH, KARL HARRY FERDINAND
SACHS, JULIUS VON
SCHIAPARELLI, GIOVANNI
STAS, JEAN SERVAIS
STOKES, SIR GEORGE G.
STRASBURGER, EDOUARD
STRUVE, OTTO VON
SUESS, EDUARD
SYLVESTER, J. J.
TISSERAND, F. F.
VIRCHOW, RUDOLPH VON
VOGEL, H. C.
WEIERSTRASS, KARL
WEISMANN, AUGUST
WÖHLER, FRIEDRICH
WÜRTZ, ADOLPH
ZIRKEL, FERDINAND
ZITTELL, K. A. R. VON

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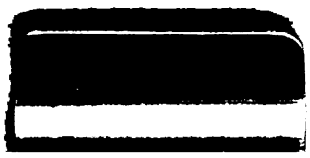

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